Motivational Differences in Science Course Enrolment Shown by Males and Females in Grades 9 through OAC

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Abstract

A sample of 1,345 students enrolled in advanced-level science courses from Grades 9 through OAC was surveyed in order to gain perspective into the existence of motivational differences attributing to science course enrolment by gender. Records of enrolment were examined in order to detect patterns and trends. A questionnaire was devised and piloted. It measured five motivational variables - demographics, science and science-related experiences, science ability and attitudes, impressions about women in science, and importance of science and science-related skills. The students also provided some impressions about the image of scientists. Results of the questionnaire were analyzed for frequency of responses and for significant gender differences using the chi-square. Differences were found to exist in the areas of science anxiety as it relates to testing and oral participation; in motivation generated by the performance of extra-curricular science and science-related activities, and by the classroom environment; in impressions of women in science; in the importance of science skills, and in the area of teacher influence. The study also showed a differential enrolment of females, with an emphasis on biology and chemistry. The males were enrolled in courses of physics and chemistry. The findings lead to numerous suggested strategies and programs for encouraging the participation of females in science education and careers.

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Table of Contents

List of Tables

List of Graphs

CHAPTER ONE: THE PROBLEM

Introduction

It has become apparent, over recent years, that changes have occurred in the areas of science and science education. Advances being made and numerous employment opportunities are available in the areas of science and technology.

Changes have also occurred in the classrooms of the local high schools. It would appear that girls are continuing to study science throughout their secondary educations, even more so than they did 10 to 15 years ago. An examination of some more recent data, obtained from a local secondary school, reveals that some areas of science, biology for example, are far more frequented by girls than other areas such as physics and chemistry. Generally, there still appear to be more males enrolled in science beyond the tenth grade, as there has always been in the past.

This study seeks to determine the extent to which girls are, in fact, continuing science studies. Further to this, it is the intention of this study to investigate and identify the factors and important variables which aid in motivating girls to continue to enrol in science courses.

Background of the Problem

The issue of girls and women in education and in the work force is not a new one. Literature shows that women have been avidly researched over the years. Stereotypes and perceived characteristics have always played an important role in the determination of the goals that a woman could reach. Perhaps this is still true, even if it does not occur to the same extent.

> Most societies have different expectations of the adult roles of men and women, with men generally in dominant and women in subordinate positions. In many countries this is associated with men working outside the home in a wage-earning capacity and women working as home-makers and food processors... (Harding, 1985, p. 555.)

While this seems to be changing in North America, it would seem obvious that such expectations, which have existed for so long, will take at least as long to be modified and overcome.

Evidence that people's outlooks are changing lies in the fact that Canadian women are now more actively involved in the external labour force. This allows them to purchase items that, historically, they produced in the home. There also seems to be a substantial change in women's self-images, which would have some effect on their ultimate involvement in the work force (Ontario Women's Directorate, 1985).

To focus on education, studies have shown that females in the labour force are somewhat better educated than their male counterparts. The emphasis of women's education still remains in arts programs or traditionally female occupations, however. (Ontario Women's Directorate, 1983.) It seems necessary, therefore, to continue to monitor science studies and highlight all the possibilities that a science or science-related career can offer.

Statement of the Problem Situation

The future of professional science and related areas will see a marked absence of females if the present rate of enrolment of girls in today's science classes is to continue. This concern provides the basis of the problem to be investigated by this study. It is important to know the exact standing of girls in science courses before any attempt for change can be pursued. By investigating the motivational factors behind the decision of girls to continue, or not to continue, studying science, the areas which require greater attention can be identified. With this information, girls can then be encouraged to study science, to see the importance of such studies and the skills they impart, and the effects of all of this on their future careers.

The Purpose of the Study

The purpose of this study is to examine a Roman Catholic secondary school population in a southern Ontario school district and to gather statistical information of males and females studying science at the advanced level. Such information will then be analyzed to determine the existence of motivational differences between boys and girls, as well as reasons for the differences.

Underlying this will be the questions:

1. Who is continuing to enrol in science?
2. Who is not continuing to enrol in science?, and
3. WHY?

Objectives to be Investigated

In addition to the main questions mentioned above, several objectives will be considered. They are:

a) to examine data from the Ministry of Education for the particular schools in question, for figures on enrolment of boys and girls in advanced level science classes;

b) to examine a number of research variables (such as demographic data, socioeconomic background, achievement, attitudes, teacher as instructor preference, class make-up) and the extent to which they influence or motivate students to continue to enrol in science courses;

c) to determine if differences do exist between boys' and girls' enrolment patterns based on the responses to a questionnaire, which will take into account the variables mentioned;

d) to compare by age, students with respect to ideas about science and their future interests;

e) to identify any specific needs of girls in science programs which may or may not be present in the existing curricula (such as required skills, knowledge, methodology, role models, guidance and career counselling);

f) to discuss programs designed to assist and encourage students, especially girls, to continue to study science.

Importance of the Study

The results of this study can be used to develop methods which will heighten the awareness of the usefulness of science. The achievable, marketable skills can be outlined, and career fields can be more adequately presented as a beginning approach to encourage continued science studies.

Definition of Terms

Operational definitions that might be helpful in the understanding of the study are offered here. In order to accommodate the different needs of students, science courses have been organized into three main levels of difficulty - basic, general, and advanced.

The <u>basic-level science course</u> is designed around themes and topics easily applied to everyday life and experiences. It tends to take a hands-on approach to the themes in order to help students meet personal needs to accept themselves, to relate to their families and friends and to cope with larger society. Through this, the students can begin to develop personal skills, social understanding, self-confidence, and preparation for the world of work. The course presents the three main disciplines of science - biology, chemistry, and physics - as well as environmental science. This serves to heighten awareness of the role of science in the life of the student. (Ministry of Education. Science Intermediate and Senior Divisions, 1987, pp. 18 - 19.)

The general-level science course is designed for students interested in employment or further studies at the community college or other non-degree-granting post-secondary educational institution. The science taught focuses on its practicality and applicability to technology, its personal usefulness and benefit to society.

While the expectations are similar to those of the basic-level science courses, the courses have a stronger focus on the disciplines of science, especially those at the senior level. These courses are designed to develop new skills and improve existing ones in problem-solving, domestic management, consumer judgment, recreational achievement, personal fitness, and employment awareness. There is also an emphasis on listening, speaking, reading and writing, and mathematics. (Ministry of Education. Science intermediate and Senior Divisions, 1987, p. 19.)

The advanced-level science course, the students of which formed the basis of this study, is designed to prepare for entry to university or certain programs of colleges of applied arts and technology. The basis is on the understanding of theoretical principles, practical applications, societal implications, and substantive content of science mainly through the processes of inquiry. (Ministry of Education. Science Intermediate and Senior Divisions, 1987, p. 19.)

It is also useful to this study to consider the image of a successful science student, which can be described using a number of characteristics. The student of science should acquire the following:

a) an interest in natural phenomena and technology;
b) an ability to understand scientific concepts and the nature of science;
c) a capability for applying investigative processes and manipulating laboratory apparatus;
d) a capacity for the retention of scientific and technological knowledge;
e) mathematical expertise;
f) some resourcefulness and creativity in learning;
g) a comprehension of the language, vocabulary, and symbols of science;
h) a sense of self-worth and a resect for other people's ideas and opinions;

i) acuity in distinguishing fact from fiction;

j) a willingness to apply learning in science to everyday life;

k) a developing sense of ethical values that relate to scientific advances and increasingly sophisticated technology.

(Ministry of Education. Science Intermediate and Senior Divisions, 1987, p. 28.)

It should be noted that the writers of the curriculum guide assume that all students have these characteristics and by studying science, they can be further nurtured and developed. Ultimately, each student is striving for scientific literacy.

The curriculum guideline Science Intermediate and Senior Divisions, 1987, Part One - Program Outline and Policy highlights a special feature of the science program - sex equity. It goes into such a detailed discussion of the need for science courses to have equal application to male and female students. Teachers should be aware of sex-stereotyping and should permit no assumptions based on gender. It is also suggested that all students be offered equal access to opportunities and experiences.

The limiting effect of the scarcity of female role models is also considered, as is the outcome on females of family and peer influences, classroom activities, and teacher expectations. It is emphasized that technology is causing greater competition for women for skilled technological occupations traditionally held by men. Yet, these occupations are offering women new forms of employment requiring different skills such as computer, mathematics, science, and technology. In order to achieve these skills, teachers must offer more adequate encouragement and counselling, and must promote a more dynamic image and vision of the capabilities of women and the contributions that they can make. Furthermore, teachers must be aware of their own attitudes and expectations for possible stereotypes. They should strive to develop in students positive self-worth, practical problem-solving, and skill mastery. In order to achieve these objectives, several suggestions are offered for use in the classroom. These can be reviewed by referring to the document, Science Intermediate and Senior Divisions, 1987.

Limitations and Assumptions

This study was limited in scope because it examined the separate high schools in a particular school district in southern Ontario. This was a narrow focus, even though the sample size was sufficiently large for such a study. The results may or may not be generalized but this could be further tested by running the same study in another area with another, similar sample.

Another possible limitation was the degree of honesty with which responses to the questions in the questionnaires were provided. While total honesty had to be assumed, especially with the assurance of confidentiality, it certainly was not always the case.

It was also be presumed that the respondents had the ability to read and interpret the questions being asked of them. Without these abilities, inappropriate responses might be submitted and, thereby, included in the results.

A certain degree of test anxiety, lack of motivation, and even fatigue had to be taken into consideration. While the degree to which these factors might have influenced the responses could not be directly measured, their effect may have had some bearing on the responses and the subsequent interpretaiton of the findings.

An additional limitation may lie in the fact the questionnaire was be administered to students taking courses on a semester system. Thus, only those students taking advanced level science courses in the particular semester of administration, provided responses. This might have limited the extent to which the responses lent themselves to generalization across the student population.

Furthermore, the size of the sample used was also based on the number of students enrolled in advanced level science courses during the semester of administration of the questionnaire (Spring, 1991).

CHAPTER TWO: REVIEW OF RELATED LITERATURE

Introduction

In accumulating the literature related to this topic, it became painfully clear that a great wealth of information is dedicated to the study of females. This literature covers all kinds of topics, theories, and perspectives. As the pieces of this particular review fell into place, it became evident that the question of girls studying and succeeding in the area of science and technology has become more prevalent in the last decade or so. The majority of the literature was found to be dated in the '80s. Older literature tended to focus on stereotypes, why females have been unable to continue science studies, and biological perspectives. This will appear more clearly as this chapter is developed. More recent literature appears to focus on abilities, achievement, attitudes, needs, and suggestions for encouragement to continue science studies.

Overall, this overview was enlightening, especially with respect to personal attitudes, teaching styles, and more positive approaches to females in science courses.

Historical Background

The historical search conducted for this study ranged from January 1966 through March 1988, using the ERIC system.

In addition to this, sources were collected through recommendation of colleagues, manual research, bibliographic examinations in especially helpful articles, and postal correspondence.

Organization of the Literature

The following outline describes the nature of the literature collected. It is based on searches ranging back from present to 1966. This outline organizes the literature into areas of importance and shows the order of their presentation without ranking importance.

A. More Recent Literature

Women's Roles in Science Education

Historical viewpoints.

Present examples of women in science

B. Research

Some Variables Considered

Attitudes.

<u>**Sex differences.**</u>

<u>**Achievement.**</u>

<u>**Teacher as role model.**</u>

C. Implications

Issues and Problems

A. More Recent Literature

Women's Roles in Science Education

Historical Viewpoints.

This section will attempt to provide a number of past perspectives which served to provide evidence or explanation for the historical exclusion of women from science.

Lee (1986) described several such perspectives. The first states that women were excluded from scientific pursuits because of biological destiny. "The 'brain versus uterus' theory maintained that women who developed their brain power did so to the detriment of their uterus and vice-versa..." (p. 21). This theory is reiterated in another article which mentions that the belief of many in the 19th century was that it was impractical and improper to extend higher education to females. Still others maintained that for humane reasons females should not be educated. "Overwork at a critical period in their physiological development would impair their reproductive capacities..." (Synge, 1977, p. 299).

Another perspective appeared in the mid 19th century. It maintained that women had smaller brains and were intellectually inferior to men. The size of the brain seemed to always be smaller regardless of which part of the brain was thought to be responsible for intelligence. (Lee, 1986, p.21).

Craniometry was replaced with the intelligence tests.

> Rumour has it that women scored higher on the first intelligence tests and that scientists hastened to "correct" them...Intelligence tests were designed to establish what everyone knew from the outset - that men are superior to women....(Lee, 1986, p. 21)

Such beliefs were eventually shown to be inaccurate due to the fact that intelligence tests have a tendency to be sex-biased.

Ultimately, Lee makes two very good points about the history of women's exclusion from the scientific discipline. First, she maintains that the scientists involved in the development of these theories were good scientists -

influential, recognized, and respected. Many who followed criticized the early declarations and continue to do so. Second, she maintains that exclusion from science still continues and women must continue to battle to overcome outdated theories and beliefs.

Scheibinger (1987) highlights the contributions of female scientists which had historically been neglected by science historians and analyzes the history of women's participation in science institutions with a focus on their limited access to the means of scientific production, and on the current status of women in science. She also examines how the sciences have portrayed the nature of women over the years.

Scheibinger (1987) cited numerous works illustrating the contributions of women in science and the underlying message in all of the writings was that while so much could be written about the contribution of women in science, ten times more could be written about men. Hence, women were seen as being exceptional. Later works sought to dispel this perception, to show that women were certainly as capable as men and could very well overcome any social barriers to their advancement.

Scheibinger examines the difficulties encountered by women within the scientific community. Once again, she cites examples that may have hindered the progress of women. In the Middle Ages, convents provided women with opportunities for learning. The rise of European universities (12th - 15th centuries) reduced educational opportunities for women. Women were only formally admitted to various European universities from 1860 - 1920. Female admittance to universities and some Ph.D. programs was observed from 1920 - 1970 (Scheibinger, 1987). This would seem to indicate that females did not advance rapidly in the field of science, despite the fact that discrimination eventually became illegal. The '80s showed some gains but, for the most part, women scientists tend to be underemployed compared to men, receive less money than men, receive no recognition for increased education (Scheibinger, 1987).

It would appear that certain barriers have served to slow down the advancement of women scientists. These barriers include teacher expectations for girls to perform at a lower level than boys, differing expectations of parents and peers, the effects of factors such as marriage, geographic mobility, and family responsibilities, exclusion from apprenticeships and informal communication networks, among others (Scheibinger, 1987). Society tends to extend its burden of expectation on its members, specifically females in this case, to the extent that females are not offered the same opportunities to education, employment and advancement.

Some historical views of sex differences are provided. She deals with the differences between men and women, tracing them to biology, and minimizes differences by arguing for biological similarity ultimately leading to social equality. From another standpoint, the author recognizes gender differences, but draws on the fact that such differences have been inevitably moulded and maintained by history and environment (Scheibinger, 1987).

These standpoints are used to explain the lack of substantial female scientific contribution. The biological determinist argument that women are not good at science is again elicited, citing statements by Hippocrates, Aristotle, and Galen as supporters of this belief. The 18th and 19th century craniologists are brought up, citing their belief that the large male skull was equipped with a more powerful brain. Darwinists are mentioned, who argued that the evolution of women was slowed at a primitive stage. Finally, the medical field of the mid 19th century maintained that women who pursued higher education would cause detriment to their reproductive capacities. The 20th century saw explanations for women's exclusion by offering research in hormones, sociobiology, and brain lateralization (Schiebinger, 1987).

More recently, feminist biologists - Birke, Bleier, Hubbard, Lowe, Fausto-Sterling - have undertaken the task of de-constructing misrepresentations of the nature or biology of women. They believe that cultural factors shape biology, which is constantly being altered by components such as diet, occupation, quality of health care, income, and exercise. Furthermore, women have been perceived as being frail because of the social expectation for ladylike behaviour, ultimately seen as a weakness (Scheibinger, 1987).

To sum up, the focus across history has been to attribute the exclusion of women from science to various biological deficiencies or incapacities. It should also be mentioned that the majority of researchers who conducted studies leading to various theories about the nature of women, were males!

McLaren writes the theory of socialization, which "helps to explain how men and women accept their differentiated places in society and how the gender order is reproduced from one generation to another" (McLaren, 1987, p. 333).

The theory of socialization and its followers take into account several assumptions:

> that the content of socialization is unproblematic; that individuals are passive in their acceptance of ideas and values; that the psychological relationship between the primary agent of socialization and the individual is positive and reinforcing; and that the perceptions and plans of individuals are unaffected by the availability of

> opportunities in a society. (McLaren, 1987, p. 333.)

The author goes on to illustrate how these assumptions make the theory somewhat shaky.

Girls become socialized into feminine roles through identification with their mothers. This ensures the continuation of male dominance in society. The argument lies in the fact that girls are not always passive about accepting these roles and sometimes question the roles, especially if their mothers do not serve as particulary positive models (McLaren, 1987). It seems apparent that girls will make their own decisions based on their experiences with their mothers and then may or may not choose to take on similar feminine roles. As the author puts it -

> while values and ideology are crucial for understanding women's position, we should not be blinded to the material constraints with which women are confronted. The real lack of opportunity for women surely affects how they perceive the world and their place in it....Not only do women realistically take into account the constraints that face them, they may actively struggle against those constraints...The theory of socialization

> tends to suggest that women have "chosen" their positions in accordance with traditional values. It does not acknowledge sufficiently that women find themselves forced into their position due to misogyny, discrimination, neglect, or harassment. Nor does it acknowledge that the odds against women changing their positions are quite staggering... (McLaren, 1987, p. 335.)

This argument is realistic, forcing one to admit that while some theories might explain certain aspects of gender differences, they cannot explain everything. Women have fought against their position of inferiority in society and continue to do so. A woman's place in society is ultimately determined by a number of factors, not the least of which is her experience and her decision-making.

Present examples of women in science.

Six female scientists share their perspectives and reflections. The emphasis is on their lives, early influences, careers, and the future. The scientists are Margaret B. Adams, Gertrude Scharff Goldhaber, Judith Graham Pool, Dixy Lee Ray, Vera C. Rubin, and Neena B. Schwarz. Each of these women holds several scientific degrees in many areas of science -

anthropology, physics, physiology, marine biology, zoology, and astronomy.

Adams discusses the early paternal influence she experienced which later had great effect on her choice of careers. She also makes mention of the difficulties she faced when trying to embark on a career in geology, as recently as 1968. It was not a "women's field" (Adams, Goldhaber, Pool, Ray, Rubin, and Schwarz, 1973, p. 15).

Goldhaber (in Adams, 1973) cites the need for curiosity and extreme self-confidence in order to be successful in a science career. "In the United States, the belief that it is unfeminine to excel in a pursuit usually relegated to men adds a tremendous inner constraint to the great hurdles existing in the outside world." (Adams et al., 1973, p. 15.) She goes on to say that the European female scientists pose a great example for others in that they show that a female can overcome all difficulties to achieve a career and yet experience satisfaction and success.

Pool (in Adams et al., 1973) comments, "Nowadays, in my opinion, there is no question but that every bright girl should aim for and participate in a serious career whether or not she undertakes the roles of wife and mother....Small families and improved technology...mean that such a girl will have ample opportunity to develop her individual potential..." (p. 15).

Ray (in Adams et al., 1973) reiterates this opinion and stresses that female students of science must be willing to work and never give up. The combination of a career and parenthood can work if understanding and support are main ingredients in the relationship.

Schwartz (in Adams et al., 1973) discusses the satisfaction that a career in science offers as a result of its creative nature, emphasizes the need for the development of powers of observation and the need for reading, and the encouragement of females to enter science programs. She agrees that a career and a family can be managed provided there is an equal sharing of rights, privileges, and responsibilities as parents between spouses.

The message seems to be that any goal can be achieved with persistence and hard work. Barriers can be overcome and women can serve as models to others once their own objectives have been met.

Kadar and Shupe (1977) write about heroines of science in order to show that there are many examples of women who made important contributions over the years. They provide role models for young girls so as to influence their futures. "Role models have special impact on the young, who are really quite conservative in terms of deviating from the social norm. Thus we risk limiting youngsters' future contributions unnecessarily when we do not even accurately portray the range of life styles and occupations that are open (and opening) to them" (p. 39).

It appears that an abundance of female contribution is also illustrated. It reflects work done in many areas of science and shows significant discoveries. It would be a worthwhile task for young students of science to research these personalities so as to further understand their achievements regardless of their limitations at the time.

Additional role models in science are offered by Nina Matheny Roscher's Chemistry's Creative Women (1987). Some of the same names that appeared in the previous article, Cori and Pennington, also appear here. Among the names cited, without going into great detail, are Emma Perry Carr, Mary Lura Sherrill, Lucy W. Pickett (group researchers), Icie Macy-Hoobler, Agnes Fay Morgan, Pauline Beery Mack, Gladys Emerson (leaders in nutrition), Gertrude B. Elion, Mary L. Good (women in industry), Sarah Ratner, Mary Locke Petemann (women in biochemistry), Isabella Lugoski Karle (woman in government). Their inclusion in this article is to provide evidence for students that there are many women working in science and to also provide inspiration for those who wish to pursue careers in science (Roscher, 1987).

E. A. Cebotarev (1986) writes about the contributions of women to agricultural science and technology. She feels that women and their attainments in this area have been neglected by scientific historians.

During prehistoric times there was "woman the gatherer" who was perceived as providing about 80% of the food by such means as hunting and foraging. Women controlled the supply of food, processed it, and distributed it to members of the family and group. This type of activity lead to women being credited for the discovery of cultivation and the domestication of plants due to the nature of food collection during that time. Women of this period are also credited with the invention of food-gathering tools such as digging sticks, carrying slings, knives, mortar and pestles. Methods of food preparation and storage have also been attributed to women of prehistoric times (Cebotarev, 1986).

In areas all over the world, the nature of social organization made women responsible for food, which involved the cultivation of plants and the knowledge of plant and animal life, soil, climate, and seasons. Women domesticated plants and animals, invented selective breeding and control of pollenization, propagation by shoots and cuttings, seed selection and construction of seedling beds. Due to all of this responsibility, women also developed all kinds of inventions to help them achieve their goal of keeping their families fed. Food processing and preserving and the necessary implements are also a result of the role of women as food providers (Cebotarev, 1986).

With the development of agriculture, the socio-economic roles of women began to decline. Women were totally excluded from cultivation, were allowed to perform only menial tasks, and generally lost their status (Cebotarev, 1986).

The popularization of science is an area where women have had a key role over time. Popularization involves translation of research from foreign language into modern language, adaptations of high-level work for general readers, writing of textbooks, public lectures, literary expositions, essays, science teaching, conferences and meetings, and children's literature. Women had a prominent role in popularization in England during the 18th and early 19th centuries. They were very much involved in studying various sciences, writing books about scientific knowledge for other women and children, and pursuing the area of juvenile publishing. It gave women a certain degree of independence and gave science a somewhat female perspective (Shteir, 1986).

The final article in this section examines the need for documentation of women scientists in Canada, having been overlooked until recently. Ainley (1986) researched Canadian women scientists over the period of 1890 - 1950 and found biographical and bibliographic information on over one hundred women. The search was not an easy one. "Documentation is badly needed to help provide a clear picture of the socio-economic and cultural factors responsible for the current status of Canadian women scientists, and their historical role in scientific education and research" (Ainley, 1986, p.7). It would appear that there have not been instances of accurate methods of keeping records of the accomplishments of women in science in Canada in the past.

Ainley (1986) does list several prominent scientists and their accomplishments, and cites difficulties encountered by scientists - lack of funding and time for research, conflicts between career and marriage, opposition to women in field work or advanced studies, anti-nepotism regulations preventing working women from marrying and married women from working, isolation for research in ornithology and geology, and great discrimination.

In order for Canadian women scientists to be fully recognized for their accomplishments, better efforts at keeping detailed records and documents about their research and experiences are required. It is necessary for Canadian students to see that there are role models and examples of exceptional women in Canada and that the distinction of being recognized for one's efforts is not limited to foreigners only.

Many other authors have written about women in science, primarily for the purpose of presenting modern role models for students. Brush (1985) describes discoveries made in physical science by ten women who were not given credit for them. Ellis

(1986) discusses the history of women's success in math and science and encourages girls to enter the field of engineering. Bondar (1986) writes about the effects of her early science experiences on her future in the study of space as astronaut and scientist. She focuses on support received from parents, relatives, teachers, and scientists. Morisset (1986) also presents the early influences of parents. She explains how a combination of interests in math, science, needlework, sewing, and design led to a career in biotechnical research. The Ontario Ministry of Education's document, Sex-role Stereotyping and Women's Studies serves as a unit of study for students and teachers. It focuses on a number of women who led movements to bring about political and social change.

The articles cited above give numerous examples of women in science. There are many more women who have made significant advances in all branches of science and have not appeared on these pages. Those who were mentioned serve to depict the variety of accomplishments made by women and are certainly worth examining with any group of students.

Historical perspectives, theories, and opinions, the presence of women in science across historical times, and societal pressure have definitely led to the development of certain beliefs and attitudes by members of society, especially young people. The next section will examine some of the attitudes that have prevailed over the years, as outlined by studies of students. The examination of these attitudes will help to highlight some of the variables responsible for the enrolment patterns for science courses at the secondary school level.

B. Research

Some Variables Considered

Attitudes toward science.

The presentation of the literature related to this topic is given in chronological order, with a discussion of the findings of each. Subsequently, common elements about attitudes will be drawn and summarized. The articles range in ideas from the rating of scientific skills, to stereotyping, to perceptions of self-image, and the development of attitudes in general.

Lodge (1969) had a sample of high school students rate 18 science skills. The group was divided into junior and senior, male and female students. The findings are as follows:

> At the 1% level of confidence (sic), measured by a "t" test, the senior high boys rated the

> skills to measure and to evaluate higher than did the junior high boys. Likewise, junior high girls placed to classify higher than senior girls....Within the 5% level of confidence, the following differences were significant:
>
> > to read, to observe, to recognize problems rated higher by senior high boys; to classify rated higher by junior high boys; to evaluate rated higher by senior high girls; to select the most likely "possible answer" of a problem for testing rated higher by junior girls....
>
> Differences by sex were also observed. Girls rated to classify higher within the 1% level of confidence, and to read and to record higher within the 5% level. (Lodge, 1969, pp. 421-422)

Lodge (1969) alludes to the fact that the differences found had a tendency to be for instrumental skills versus problem-solving skills and offers that the students may not have had a good understanding of these skills at the point of rating them. He attributes difference in opinions to age and sex, as shown by his results.

From this author's perspective, it would appear that girls tended to favour organizational skills (classifying, recording, reading), while boys emphasized evaluation and measurement skills. This may be proven true by other studies which follow.

Pendleton (1975) discusses misconceptions about science and the need for changing attitudes. She quotes, "many girls believe the myth that scientists spend their lives in basements, working seven days a week, night and day" (Pendleton, 1975, p. 171). Furthermore, many are concerned with avoiding eventual job and marriage conflicts over discrimination, money, and advancement (Pendleton, 1975).

It appears that females are less interested in science than males. Those females who do show interest achieve high grades, participate in extra-curricular activities, and often have the support of at least one parent in science-related employment. These girls are interested in pursuing education beyond high school and require career counselling (Pendleton, 1975).

Levin and Fowler (1984) make several statements which emphasize that there are fewer females than males in science and math studies in high school, and in science/engineering fields in college. Causes for this sexual discrepancy related to innate biological differences and differing intellectual abilities are suggested and then rejected. Differential cultural influences are better supported as being responsible for the difference (Levin and Fowler, 1984).

Using eight attitudinal variables, the researchers found that females had less tendency to stereotype science as a male domain. They also believed that they would receive more positive consequences from successful science studies than males. The girls perceived greater encouragement and positive support from teachers. These were the three subscales on which the females showed significant differences when compared to the males in the study (Levin and Fowler, 1984).

The five remaining subscales showed males scoring higher than females, but the differences were not significant (Levin and Fowler, 1984). This might indicate more positive attitudes on the part of the males and therefore might be reflected in enrolment figures. This information was not provided in the study.

Males and females both perceived the greatest positive encouragement from teachers and the least from fathers. This was also supported when the three grade levels were compared (Levin and Fowler, 1984). These results might lead to some differences in enrolment patterns in science programs and will serve as a good source of comparison for the study to be conducted.

It was interesting to note that the students in advanced courses had the most positive attitudes on the majority of the subscales. This could be attributed to ability differences or the amount and type of science studied. This was not supported by evidence in the study when advanced and general placement students were compared (Levin and Fowler, 1984).

The authors end the study with several suggestions for the fostering and development of positive attitudes in students who will eventually form a major part of the work force. They suggest the use of other academic courses, such as English and social sciences among others, to nurture more positive science attitudes and communicate them more effectively. They encourage the importance of parental influence on continuing science enrolment by means of adult continuing education, PTO meetings, newsletters, etc., as well as, curriculum design, inservice teacher training, reduction of sex-biased attitudes, and coping strategies for females (Levin and Fowler, 1984).

Matyas (1984) examines the effects of gender, race/ethnicity, and school type/location and anxiety among secondary school students. Of interest is the effect on gender. Data were collected from students in seven high schools, enrolled in biology taught by exceptional teachers, using a battery of surveys and instruments. Variables being considered included science anxiety, attitudes toward science and scientists, participation in science activities, among others.

While several dependent variables are dealt with, the gender differences in attitudes are of greatest pertinence here. It should be noted first that females had a tendency to choose "undecided" or central responses significantly more than males, leading to the need for alternate scoring methods (rather than simple summations of scores) to unmask gender differences. Second, girls showed less interest in science-related careers, expressed greater test anxiety, less confidence in scientific problem-solving abilities, admitted to less frequent participation in science activities when compared to boys (Matyas, 1984).

Such attitudes would eventually have some effect on female enrolment in science courses and on science career interests. Since it appears that female feelings play an important role in their attitudes, it would make sense to foster positive feelings about science classes and women in science. It would also be beneficial to "make young women feel serious, confident, and successful, not stupid and afraid to ask questions" (Matyas, 1984, p. 10).

In another study, seven Likert items that measure attitude toward women in science were administered to a random sample of 17-year-olds. Several aspects of this were considered in terms of student perceptions: knowledge, competency, careers, technical skills, and logical reasoning (Welch, Rakow, and Harris, 1984).

Findings showed a positive attitude toward the role of women in science among the 17-year-olds questioned. The girls, however, expressed significantly more positive attitudes toward women in science than the boys. Further to this, the boys were shown to have more negative male attitudes (sex-bias) toward their female class mates (i.e., boys were less likely to believe that women could be equally successful in science as men) (Welch et al., 1984).

These findings seem to indicate a certain environmental pressure that is experienced by females when considering science study. It might have a negative effect on girls, both in their achievement and career choice. Peer pressure presents a real barrier for girls considering continued science study.

The idea of peer pressure seems to be further supported by MacCorquodale (1984) who cites parental discouragement, male colleague resentment, and the fear of being considered "unfeminine" as important factors preventing women from entering the field of engineering. She continues by examining such variables as self-image, personality characteristics, and inherent female characteristics, and their effect on the participation of women in science. Self-confidence, creativity, and intelligence were found to be closely linked with interest in taking science. Girls were less likely to perceive themselves as self-confident, highly creative or intelligent. Girls' hesitancy to admit to being competitive results in decreasing their interest in science (MacCorquodale, 1984).

James and Smith (1985) consider the feeling of alienation experienced by some students as an important contributor to declining enrolment in, and negative attitudes toward science. They examine the grade levels during which alienation appears to have an effect on female students' subject choice. In general, the data showed the most significant decreases in positive attitudes occurring between sixth and seventh grades. This was also true for females. The authors offer as explanation, the treatment and evaluation of science as a separate subject for the first time in seventh grade, and the sudden need for self-directed problem-solving (James and Smith, 1985). This would indicate the need for a smoother transition to science study and for a program which begins to develop and enhance problem-solving skills, with an emphasis on girls.

Girls into Science and Technology (GIST) was a research project which was launched to investigate reasons for underachievement of girls in science. Smail (1985) summarizes some of the results of the program. With respect to science attitudes, girls were not interested in physical science and preferred nature study and human biology. There was a decline, in the third year of the study, by both boys and girls, in interest levels about science and scientists. As well, the more able students showed greater interest. There were differences, by the fourth year, in perceptions about the usefulness of science for employment, with boys perceiving physics and technology as more useful for jobs than did girls. "Girls saw physics as less useful for a career, less enjoyable and interesting, and they underestimated how well they performed" (Smail,1985, p. 351). Again, the ideas of self-image and confidence are elicited.

The project also revealed more sex-stereotyped behaviour on the part of boys, as evidenced by opinions about women's knowledge and domineering laboratory behaviour. On the other hand, after being exposed to programs of real role models, posters and worksheets, discussions, and career advice, the girls in the group appeared to become more egalitarian. They expressed interest in some scientific jobs and felt apt to be employed after marriage and children (Smail,1985). While this may not necessarily reflect a change in attitude, it does reflect the benefits of advancing knowledge.

Simpson and Oliver (1985) suggest a lack of background and mixed feelings on the part of adolescents entering science courses has a definite effect on the nature of their experiences and perceptions about the subject. They emphasize that these attitudes prevail during middle and secondary school years and that males possess more positive attitudes and tend to be motivated to higher achievement.

Examining gender differences in attitude only, it was shown that males had significantly more positive attitudes toward science across all grades, except Grade Nine; attitudes became more negative from the beginning to the middle of the school year. Furthermore, interest in the sciences declined significantly from the seventh grade (life science) to the eighth grade (earth science). Females were more highly motivated to achieve than males, contrary to earlier statements (Simpson and Oliver, 1985). The following summarizes the consequences of their findings.

> Science courses commonly taught to adolescent students in most school systems do not produce individuals with positive attitudes toward science and do not produce students eager to continue taking science courses in high school and college. These results suggest that, if positive attitudes toward science are among the important goals of science education, changes in science courses for adolescent students need to be considered....Furthermore, if most individuals turn away from science by

> the end of high school, is it not predictable that parents, political leaders, and even elementary school teachers will not value science as a basic subject of study and activity in our society? (Simpson and Oliver, 1985, p. 523)

Taylor and Mardle (1986) conducted a longitudinal study of the perceptions of young people to gender role stereotypes. With respect to domestic roles, boys had a greater tendency to believe that women should remain in the home, than girls. The girls felt that child-rearing should be a shared experience, while the majority of the boys felt that this should be a primarily female responsibility. A majority of boys were more mellow toward domestic routines, admitting interest in cooking and assisting with chores. The girls revealed a definite feeling of injustice in that they felt that boys could easily get out of performing these chores (Taylor and Mardle, 1986). Similar attitudes were revealed in the area of education. Boys expressed the belief that their education is more important than that of girls and some of the girls agreed! The idea of math being just a boys' subject was rejected by both sexes. Generally, the results illustrated "the overt and developing ideological commitment of many girls to the theory of equality between the sexes, yet when changes in actual practice are considered, more conservative and traditional views are found....Boys too show ambivalence in crossing traditional boundaries" (Taylor and Mardle, 1986, p. 206).

This study revealed many complexities and contradictions with respect to adolescent attitudes. It may be an indication that as time passes, both sexes question the traditional beliefs that they face and that, during adolescence, their own feelings and attitudes are not completely set. They may still be open to change, should it suit their personal goals. It certainly focuses on the need to adopt different strategies for boys and girls to help them establish attitudes that will allow them to succeed.

Lawrenz (1987) suggests that perception of psychosocial environment might be predictive of achievement and attitude. The results showed gender-related differences in perceptions of classroom psychosocial environment, with the differences becoming more pronounced as age of students increased. There were no perceived differences in classes taught by males and females by students in fourth and seventh grade classes. Between seventh grade classes, however, some differences existed. Classes taught by females were perceived as more difficult and girls with male teachers perceived classes as more cohesive. The combination of opposite genders of teachers and students appeared to lead to less competition and friction, and more satisfaction for students (Lawrenz, 1987).

These results are indicative of the problem faced by girls in the sciences.

From this study, another set of attitudinal complications is illustrated. Girls in science must deal with cultural biases, competition, friction, and low cohesiveness. All of this must have some effect on their attitude toward continuing the study of science.

Attitudes toward science could also very well be influenced by feelings about new technology. "There is well documented evidence that females are less likely to take up technological training or jobs, and that teenage schoolgirls have attitudes less favourable to science and industrial work" (Fife-Schaw, Breakwell, Lee, and Spencer, 1987, p. 114). From this stems the idea that subject content may be partly responsible for either promoting or not promoting favourable attitudes toward science and technology.

Of interest are the findings for the general benefits of technology and the "green" issues (peace and environment). Females perceived less potential benefit of technology than males, indicative of gender differences. On "green" issues, students having not taken physics or chemistry or computer science were more sympathetic to environmental and peace issues when compared to students who had taken these courses. The researchers attributed this to the focus and content of courses and their role in the socialization of the individual.

The authors' findings led to the emergence of a pattern, that past scientific orientation of subject choice has an effect on attitudes toward the impact of technology on the environment and peace. Since there were no gender effects for this, it was suggested that "scientific orientation is a real, across-gender factor associated with attitudes...and...females may have low evaluations of the benefits of technology whilst still having otherwise positive attitudes to training..." (Fife-Schaw et al., 1987. p. 120).

All of this leads to the implication of the role of subject choices on attitudes. Adolescents tend to choose, and remain with, scientific orientations, as deemed by educational institutions and requirements. There is some psychological development which results, nevertheless, which may be tapped to steer students toward science and technology training. (Fife-Schaw et al., 1987).

In <u>A Teenager's View of the Nature of Science</u> George (1987) examines the feelings and perceptions of a fourteen year old female on the nature of science. Of particular interest is the student's idea of a scientist, his physical characteristics, qualifications, and roles. The subject described a typical scientist as a tall, grey-haired male, fifty-ish, in a lab coat, wearing glasses. In terms of qualifications, she believed intelligence and knowledgeability to be important to the pursuit of a science career. Comments about the role of the scientist focused on the social aspect of science, with major work leading to cures for diseases. Overall, her view of the scientist was that he is a "good" person because of his ability and willingness to help.

The subject showed a positive attitude toward science and scientists. She trusts and believes in science as having value to society. She uses science as a means to learn but has not developed an understanding of all aspects of the scientific method of problem solving.

The author cites a study done in 1957 by Mead and Metraux, whereby

> most students perceived a scientist to be a bespectacled intelligent, middle-aged man who wears a white coat and does research in a laboratory, is dedicated, does not work for money, or fame or self-glory, but for the benefit of mankind, creates new inventions, discovers cures for diseases...(George, 1987, p. 55)

The subject's view paralleled the perception of 35,000 teenagers! It strongly suggests that whatever changes have been adopted over the years have not really altered the stereotypical image of the scientist (George, 1987).

In her view of science, the subject expressed a liking for the subject, except when she experienced confusion or lack of understanding. This was attributed to the effect of a particular male science teacher (George, 1987). It would seem that the impact that a teacher can have on a student is quite important to his/her perception about the subject and his/her ability to learn it.

This idea about the image of the scientist was also addressed by Dr. Linda Fischer at a conference conducted by the Science Council of Canada in 1981. She links this with socialization in that a child may be interested in becoming a scientist if his/her image of the scientist is compatible with his/her image of himself/herself. According to Fischer,

> scientists are thought to be more than normally meticulous, dedicated, intelligent, logical, impersonal, ambitious, and very masculine. Their work may be regarded as exciting and productive, or as boring and repetitive and generally useless or even destructive." (Science Council of Canada, 1981, pp. 63-64)

Perhaps then, socialization of boys and girls greatly contributes to the development of attitudes with respect to science. Society has general concepts about masculine and feminine behaviours, which constitute sex-role stereotypes. These stereotypes are often reinforced and encouraged by social institutions like schools, and by parental expectation, peer pressure, teachers, and the media.

> North American society tends to socialize males to become "providers" and females to become "care givers". Behavioural traits such as independence, assertiveness, objectivity, dominance, competitiveness, liking for science and math, ambition, decisiveness, etc. were all rated as masculine by subjects in one study. Feminine behavioural traits, called "warmth-expressive" included tact, gentleness, talkativeness, quietness, neatness, interest in appearance, awareness of feelings, security orientation and religiousness....These characteristics would not seem conducive to interest or achievement in this area (science). (Science Council of Canada, 1981, pp. 64-65)

Hence, the girls who have taken on feminine stereotypes are forced to deal with their impact while they make course choices, all during adolescence.

The effect of stereotyping is often seen in the use of approval and/or disapproval of certain behaviours. Girls who conform to expected behaviour tend to receive approval. As a result, some continue to behave accordingly in order to continue to receive external rewards for their competence.

> Because girls receive approval for neatness, conformity, and good behaviour, they tend to adopt a very passive approach to learning. Previously successful patterns of behaviour are repeated in preference to the risky, more challenging business of attempting new solutions to more difficult problems. Thus it seems girls tend to become less independent and self-confident, are less likely to become involved in scientific areas, particularly if these areas are perceived to be both difficult and masculine. (Science Council of Canada, 1981, pp. 68 - 69)

Thus is added yet another link in the chain of possible factors contributing to the formation of attitudes by young women. These attitudes have some effect on the enrolment of these young women in science courses beyond those that are absolute requirements for the completion of their education. Sometimes, the stereotypes that girls see are the products of traditional upbringing and fear of the adoption of more modern, possibly less conservative, views. The older generation has difficulty in doing this, so it falls upon younger generations to begin to make the necessary changes toward the adaptation of a new outlook toward women, their roles, and their ability to succeed in any area they choose.

A survey of senior Physics students, conducted in Ontario by the Ministry of Education (1988) offers several student attitudes toward science that may indicate that a move toward change is beginning. Attitudes toward physics and several related areas were gathered by focusing on laboratory work, careers in science, science and society, gender and science, science as a process, and physics in schools. It appears that, for physics, attitudes are generally positive, especially toward experimentation and the presence of females in science. A similar review was conducted for senior Chemistry and the attitudes directly paralleled those obtained in the Physics review.

To recap, attitudes have direct, and possibly indirect, effects on the decision making process leading girls away from science study. This section has outlined a variety of attitudes, the manner in which they may have been acquired, and the consequences. The effect of cultural influences was examined with an emphasis on the socialization of children to traditional male and female sex roles from a young age. Girls have less tendency to admit to self-confidence and intelligence, and tend to conform to acceptable behaviours in order to receive external rewards. This carries over into science where they are faced with environmental pressures in the classroom, by their peers, and from the teachers. At the same time, there is alienation from science interest during specific periods (seventh grade, high school). Girls also experience a greater degree of science test anxiety and rather mixed encouragement from teachers. Subject content was also considered to be a contributor to the formation of attitudes, not necessarily positive, toward science.

Females tend to have a more positive attitude toward women in science but also show some reluctance to cross traditional female sex role barriers in order to pursue their own science careers. This is shown by the emphasis of certain science skills to be masculine (observation, problem-solving) and others to be feminine (classification, measurement, record-keeping). There is also a tendency to think of girls interested in science to be high achievers and avid participants of extracurricular science activities. The norm seems to be, however, that girls tend to have a very low self-image when it comes to science, especially when typically female characteristics are not really typified by the perceived characteristics of a scientist.

Sex differences.

Sex differences and sex role stereotyping have been used extensively to explain why girls show less interest to pursue science education and science-related careers. This section will describe a number of relevant articles and studies that stress sex differences, the high school, and the possible relationships to academic performance, pursuit of curricula, and occupational interests.

Synge (1977) discusses such relationships by examining the various stages of education through which a student passes. She notes that there has been a lot of work done attempting to prove the existence of biological differences and early socialization patterns. Much of the work has proven to be relatively unfounded as explanation for the existing sex differences. Furthermore, the same appears to be true for IQ scores and achievement tests, even though some tend to be done better by one sex over the other.

A possible factor contributing to sex differences in behaviour and achievement may be the organization of schools. Elementary school teachers tend to be females, who show preference to girls. Secondary school staffs are comprised mainly of males. Thus, a mixed message is sent to the students (Carlton, Colley, and MacKinnon, 1977).

> By the age of six, most boys see males as more powerful, aggressive, authoritative, than females, and it is hardly surprising that most girls hold the same view. Hence, the content and structure of the school, along with behaviour of school personnel, provide some of the evidence upon which young children base their conclusions about the different natures of men and women. (Carlton, Colley, and MacKinnon, 1977, p. 300)

At the secondary school stage, there are sex differences in attendance rates and courses of study, grades, lower educational and occupations expectations. Because parents often provide more support and show greater interest in the educations of their sons, girls experience confusion about their roles as adults (Carlton, Colley, and MacKinnon, 1977).

In high school, girls do not appear to be encouraged toward competition and achievement to the same degree as boys. Teachers encourage feminine behaviours, and girls who do deviate from this type of behaviour are perceived as aggressive. The girls themselves see this as a means of becoming less attractive to males. In addition to this, girls still hold the belief that their own futures are contingent upon the success of their husbands' careers, not their own (Carlton, Colley, and MacKinnon, 1977).

This is supported by Gaskell (1977) who states that this view is responsible for the distribution of power and opportunity in North American society. She conducted a study to examine the effects of sex-role ideology on the aspirations of high school girls. The results showed that the acceptance of traditional beliefs about feminine behaviour functioned to reduce the aspirations of the girls in the study. Results also indicated that girls had less traditional sex-role beliefs if they aspired to professional occupations. With respect to occupational commitment and marriage aspirations, girls with traditional sex-role beliefs showed high aspirations. That is, they tended to believe that males should have the dominant role in a relationship. Furthermore, an examination of the power scale, which reflected girls' self-confidence and abilities, showed that it was a consistent predictor of aspirations. The more confident in herself and her abilities a girl is, the greater her desire to take responsibilities for her own actions as opposed to dependency on males (Gaskell, 1977).

Thus we see the role of traditional sex-role behaviours as an important, if not inherent, contributor to the aspirations of high school girls. There still appears to be the high presence of the belief that males will determine the future, and possibly, the success of females.

Russell (1979) cites similar conclusions indicating that young women at the secondary school level do place great value on the attentions of boyfriends, sometimes to the detriment of their own achievements. The article goes on to consider this female attitude as a result of the role of the secondary school in sex-role socialization and allocation to occupational sex structure. That is to say, how does the school and its personnel interpret, type, and process the behaviour of females?

The study revealed that a third of the girls interviewed experienced a decline in grades over the four years of high school, attributing this to decline of interest. Boys, in the same proportion, experienced an improvement in grades, attributing this to more effort and greater interest. The author offers an explanation for the cases where the opposite was true (i.e., boys' grades declined, girls' grades increased). "Losing interest in school, or alternatively becoming more interested, in the crucial last years of high school, reflects in part, an adjustment to goals conspicuously and comfortably open to an individual, given their sex and social class" (Russell, 1979, pp. 60-61). That is to say, motivation to succeed plays a role in the outcome of the student's achievement.

With respect to choosing occupations, most of the group interviewed made standard sex-stereotyped decisions (i.e., those whose original aspirations were to become doctors and parole officers, ended up choosing lab technician and teacher as careers). These choices were made at a very young age. Others who aspired to be teachers or child-care workers, chose librarian assistant and secretary as careers. Such choices were made around puberty.

> Whichever patterns these girls followed, their ultimate choices ensured the perpetuation of the sex segregated occupational structure.... Reasons they gave for lowering of expectations involved boyfriends and feelings of inadequacy for work originally chosen. (Russell, 1979, p. 62)

The school thereby functions to help stabilize sex-roles and class structure of society.

Some of the teachers interviewed made comments about student behaviour and achievement. Boys were considered to be more open, fun, forthright, better able to specify their own problems, by women teachers. Male teachers felt girls were overachievers and that boys were better students. Thus we see boys receiving rewards for being independent and assertive (Russell, 1979).

Counsellors were also interviewed. The message males tended to convey to girls was that managing a career and a family cannot be done well and one female counsellor, while encouraging girls whenever possible, told them there is trouble and difficulty in the pursuit of a typically male-dominated occupation (Russell, 1979).

There is an obvious tendency for boys and girls to behave in ways that are expected for their respective sex, and there is encouragement for such traditional behaviours. The students choose traditional sex-typed careers because they experience support and perceive rewards for doing so. In other words, students are still discouraged from moving away from the traditional sex-role behaviours and occupations.

This attitude was reflected in the deficit model of the early sixties, in which feminists focused on both the financially disadvantaged and girls. The feminists argued that girls lacked skills and attributes that would permit them to be successful and that society must address this fact. This led to extensive research on sex differences in the '60s and '70s.

> The fear was that little girls who learned to be quiet, to be feminine, and to put other people's needs first would not become intellectually aggressive enough to excel at school. Girls are discouraged from growing into intellectually inquisitive, independent, and self-assured persons. They are inhibited with regard to the acquisition of qualities that are highly valued in our society, and therefore are prevented from mastering the skills and achieving the status that would allow them to participate in the power structure. (Gaskell and McLaren, 1987, p. 106)

This presents a barrier for women and indicates conflict between achievement and femininity.

Other characteristics cited as preventing women from experiencing success include ability and aptitude, personality, family background and support, sex-role and gender attitudes, aspirations, motivation, brain lateralization, and hormonal influence (Gaskell and McLaren, 1987).

Jan Harding (1985) writes about the perceived characteristics and status of males and females that fashion the science and technology education, specifically of girls. In general, most societies have men playing the dominant role and women in subordinate roles. This is seen by the evidence of men as the main breadwinners and women as homemakers. It is further evidenced by the assumption that the career of a man takes precedence over that of the woman and thereby limits her achievement, regardless of her academic qualifications.

Also considered are the different value systems by which young people make their decisions. The development of interpersonal ties, sensitivities, skills, ethics and values of object ties tend to form the being of a young girl. Conversely, boys focus on the solution of identity challenges, separation, and autonomy are inherent to the development of the being. This leads to different emphases on future employment criteria and on the perception of the importance of science. In addition, if nurturing is differential for boys and girls,

> in which the former may be deprived of emotional support too early and the latter denied autonomy, it may enable girls to develop a greater capacity for concern but more conformity and dependent

> attitudes within relationships, whereas for boys emotional giving becomes difficult and they seek to abstract from objects their certain, reliable aspects. (Harding, 1985, p. 558)

This may partially explain the choices made by boys toward science and technological studies as opposed to the choices made by the girls toward more care-giving occupations.

Another focus that leads to sex differences is the presence of role models, especially parents. In a study conducted by Parsons, Adler, and Kaczala (1982), the impact of parents on children's achievement concept is examined. It was suggested that "parents exhibit behaviours which children imitate and later adopt as part of their own behavioural repertoire; if important female models exhibit different behaviour patterns than comparable male models, then girls and boys will exhibit different behavioural patterns" (Parsons et al., 1982, pp. 310-311). That is to say, parents influence their children by their actions, and their beliefs and expectations about the children's success. There is a tendency for parents to expect their female children to experience a greater degree of difficulty and, therefore, a lower expectation of achievement and education.

This particular study focused on math, but its results are pertinent to this discussion of sex differences. The results indicated that the children's self-perceptions of ability and performance were not particularly influenced by their parents' role modelling. However, in terms of expectancy socializers, some influences were observed. Parents of female children admitted that more work was required for their daughters to be successful in math. Parents of sons felt math was more important for their sons than other subjects. (Parsons et al., 1982, pp. 314-315). Hence we see parents reinforcing the idea that girls must try harder, and girls believing that this is true.

Another important point must be made here. "Attributing one's success to effort is not as ego enhancing as attributing it to ability. Attributing one's successes to effort may also leave doubt about one's future performance on increasingly difficult tasks" (Parsons et al., 1982, p. 316). This seems to make sense in the area of science especially. Girls may decrease their tendency to take senior science courses because they perceive them to require a great amount of effort on their part. If they must work harder to achieve the same kind of marks as males, their efforts must increase with each subsequent course, so it makes some sense that this is an important variable.

The above suggests that parents impart different expectations to their children. Girls' success is attributed to effort while boys' success is attributed to ability. Therefore, we must consider whether there are enough differences in abilities between boys and girls to actually account for the variations in enrolment patterns in science. Hyde (1981) used meta-analysis for analyzing work done by Maccoby and Jacklin in 1974 on gender differences to try to establish the actual extent of these differences.

A statistical analysis of the data revealed that gender differences in verbal ability, quantitative ability, visual-spatial ability, and field articulation accounted for only one to five percent of the variance. The gender differences were very small. This result is then applied to counselling and gender differences in some occupations. With respect to counselling, since the gender differences are so small, there really seems to be no advantage to using them to keep females from pursuing any particular career, if they choose to do so. For occupational exclusion, however, small gender differences can generate large differences in the proportions of males and females above some high cutoff point that might be required for success (Hyde, 1981).

Sex differences in ability were also addressed by Dr. Meredith M. Kimball for the Science Council of Canada workshop (1982). She argues that any perceived differences do not exist because of nature but rather are products of the environment to which children are exposed. If there is some predisposition to weakness in a particular of ability, then it should be developed, not used as an excuse to avoid certain areas of study (Science Council of Canada, 1982). The fact that gender differences in ability are very small is once again cited, which concurs with Hyde's findings mentioned previously (Science Council of Canada, 1982).

Dr. Kimball goes on to discuss three areas where gender differences have been found to exist: visual-spatial ability, mathematical ability, and verbal ability. She offers biological explanations for these differences in abilities. The first is the X-linked hypothesis, which hypothesizes that the X chromosome carries the recessive gene responsible for math or visual-spatial ability. Since the male needs only one X chromosome with the gene in order to inherit the ability, and the female needs two X chromosomes with the recessive gene, it seems logical to presume that there will be more males than females who end up with that particular ability. Studies of this particular hypothesis have not led to support or acceptance of this theory (Science Council of Canada, 1982).

The second theory is the role of hormones in the development of abilities, which suggests that hormones are directly responsible for two specific and opposite cognitive styles - automatization and cognitive restructuring style. Females are thought to be better at automatized tasks because of the effect of gonadal hormones. This too, has not been supported by studies (Science Council of Canada, 1982).

The third theory is that of brain lateralization, which is based on the idea that the two halves of the brain are specialized for certain tasks. There are two different theories that explain sex differences in terms of brain lateralization. One purports that more bilateral representation of a task and less lateralization results in, for example, more verbal dominance and less spatial-visual performance in girls. The second proposes that more lateralization should result in better spatial skills, as seen in males. Again, these two proposals have not been supported to any significant degree, as accounting for sex differences (Science Council of Canada, 1982).

Since none of the biological explanations held any significance, the idea that the environment plays a key role in the determination of sex differences becomes somewhat more realistic. Kimball cites one example in which the academic performance of girls was enhanced by participation in physical education. Seemingly, practice in spatial-visual activities such as throwing a ball to a specific, catching, positioning the body, helped girls develop this ability (Science Council of Canada, 1982).

High school presents students with a new environment and new pressures, not necessarily experienced in elementary school. The next few articles are addressed to this idea.

Ridley and Novak (1983) examine the notion that the low representation of women in science is related to the school socialization toward rote learning strategies. These researchers re-examine data reported by Fennema and Sherman in 1977, which reported significant sex differences in enrolment in math and science. By examining correlations between sex and grade, the results of the earlier study were confirmed in that there was a rate of decline in enrolment which was faster for females than for males. However, when this correlation was examined in absolute magnitude, the correlations ranged only as high as 0.14. This suggests little relationship between sex and grade.

The researchers go on to propose that there are differences in learning patterns experienced in school that do not necessarily lead to meaningful learning. Meaningful learning involves

> non-arbitrary, non-verbatim, substantive incorporation of new knowledge into cognitive structure; deliberate effort to link new knowledge with higher-order, more inclusive concepts in cognitive structure; learning related to experiences with events or objects; and

> affective commitment to relate new knowledge to prior learning. (Ridley and Novak, 1983, p. 313)

It is proposed that females are socialized to do what the teacher requires and accept new knowledge for its face value rather than to relate it to the real world. This is thought to lead to the development of a greater degree of rote-learning strategies for girls. Rote learning involves

> arbitrary,verbatim, non-substantive incorporation of new knowledge into cognitive structure; no effort to integrate new knowledge with existing concepts in cognitive structure; learning not related to experience with events or objects; and no effective commitment to relate new knowledge to prior learning. (Ridley and Novak, 1983, p. 313)

In any subject, prior relevant concepts influence subsequent learning. In high school, it seems necessary to integrate concepts into hierarchical frameworks of meaning which span the entire course in order to produce more meaningful learning strategies. This cumulative effect of learning could develop beginning in grade school and continue through high school science courses. While this may not necessarily affect achievement or enrolment, it might serve to change the attitudes of students toward science, making them more willing to continue to study science (Ridley and Novak, 1983).

This idea of meaningful learning strategies may have some validity in explaining the lack of confidence shown by 17-year old females who took part in a study conducted by deBenedictis, DeLucchi, Harris, Linn, and Stage (1982). This study involved an examination of the responses used for National Assessment of Educational Progress (NAEP) science booklets, with a focus on the "I don't know" response.

Females were noted to have used this response significantly more frequently than males in this study. Some explanations for this frequency are proposed. Both the spatial visualization and attitudes toward science factors were considered but were found to have no real effect on the total scores. So, she considered gender differences in uncertainty. She explains that the reason for this tendency for females to use the "I don't know" response, is because, in fact, they do not know the answer. They tend to be more willing to admit to their lack of knowledge in science than males. She goes on to consider that girls' knowledge rests on school experience, which has been shown to be less than that of their male counterparts. Females take fewer science courses, experience science as a masculine domain, deal with peer pressures, and tend to fail to keep themselves informed about women in science and current events (deBenedictis et al., 1982). All of this leads to a differentiated type of learning, perhaps rote learning, which does not build on prior knowledge to the extent that it could be applied to responding to scientific questions with any sense of confidence.

The size and influence of differences between boys and girls in science learning during adolescence is examined by Zerega, Haertel, Tsai, and Walberg (1986). This too, makes use of the NAEP mentioned above and focuses on possible environmental determinants leading to differences in science learning.

Significant effects in the comparison of males and females occurred for science achievement, motivation, homework, morale, and home, with males scoring higher in achievement, motivation, and morale and females scoring higher on quality, homework, peer, and home (Zerega et al., 1986).

By late adolescence, it was observed that males were significantly higher in scores on science achievement and motivation and had a more positive outlook on the classroom environment. Numerous explanations are offered for these findings. Males may experience greater achievement because they have a better outlook on their classroom environment. Also, since 13-year-old boys start out more motivated than girls of the same age, their levels of motivation may continue to rise over the four years of high school. For girls, on the other hand, there was a tendency to do more homework and place more emphasis on the home environment. This may be a result of experiencing success on activities related to reading and writing skills. Or, it may simply be a result of the continued perception of science as a male domain and the related conformity to expected behaviour (Zerega et al.,1986).

Tobin and Garnett (1987) took on another perspective to sex differences - that of participation in the science classroom and in related activities. Several assertions were provided as a result of the examination of the data.

> Assertion 1: Male students tend to respond to teacher questions by raising their hands to a greater extent than female students.

> Assertion 2: Target students (i.e., those observed) tended to be male rather than female.

> Assertion 3: Females engaged in individual activities in a more sustained manner than males.
>
> Assertion 4: There are no gender-related differences in teacher-student interaction patterns in individualized activities.
>
> Assertion 5: Males tend to manipulate equipment to a greater extent than females in laboratory activities.
>
> Assertion 6: Gender related differences are evident in the type of off-task behaviour of males and females during laboratory activities.
>
> (Tobin and Garnett, 1987, pp. 96-99)

Gender differences appeared to be most obvious in whole class interactions, like lectures. It was proposed that teachers have a tendency to choose students with their hands raised as opposed to admitting to a preference for male students. Similarly, males tended to raise their hands more often than females, and volunteered responses orally more frequently. This is seen as conformity with the stereotype that science has more relevance and interest for males (Tobin and Garnett, 1987).

In elective science classes, females were seen to be very capable and did have some tendency to dominate interactions in some classes. These girls were also found to be task-oriented and self-confident and motivated to learn. Females were also found to be better able to maintain sustained attention while doing seatwork, when compared to males (Tobin and Garnett, 1987).

From this, it would seem necessary to focus in on the areas where females did not perform as well as males, areas such as manipulation of equipment and response to questions during lectures. If girls are encouraged to do more of this type of behaviour, and if they can be made to recognize the benefits, their participation might increase.

One final factor that may be considered is the fact that girls take biology more often than chemistry, and chemistry more often than physics. This may be due to their perception that the latter two are more masculine type of subjects as opposed to biology. This feeling may be a product of culture. That is to say, "young girls are socialized to believe that science is not for girls..." (Bowyer, 1988, p. 22).

This tendency for girls to choose the biological sciences was reported, as well, back in 1974 by Hansen and Neujahr, who found that many female college students chose biology as their majors. They indicated that if greater participation in sciences by women is to be achieved, changes in attitudes and interests must begin at a very early stage.

Having examined a variety of articles on sex differences, one can see the effect of early socialization on girls, especially if the socialization is toward traditional sex role stereotypes. Girls have an inclination toward maintaining the norms when it comes to behaviour; they stick to the feminine, subtle, unobtrusive kinds of behaviours. They are rewarded for doing so. This has some effect on their decisions in course selections and career aspirations. The goals they perceive to be able to achieve are often greatly affected by sex and social attitude, and by environmental factors. While biological theories are suggested for their ultimate exclusion from the sciences, they are not strongly supported. Change will only result if these areas are re-evaluated in such a way as to place more attention to the participation of females.

Achievement.

Achievement was mentioned as being affected by attitudes and sex differences but must also be considered as a variable in itself. The articles to be discussed consider whether or not achievement has a relationship to course enrolment.

Schmidt (1983) examines student background and quantity of schooling as determinants of academic achievement in six academic subject areas, one of which is science. Findings after analysis, with respect to science only, indicate a decrease in quantity of science with an increase in the size of the school. More science was received by students in high-minority and/or low income schools than in other schools. In general, sex and socioeconomic status seemed to be significant variables of student background that were closely related to the amount of schooling received. In science,

> student ability was related to quantity of schooling....Those students who were more able received more schooling. Sex was also found to be significantly related to quantity of schooling. Males received more hours of mathematics and science...than females. The higher the socioeconomic status, the greater the quantity of schooling.... (Schmidt, 1983, pp. 319-320)

It would appear then that there is a positive relationship between the quantity of schooling and academic achievement. There seemed to be a positive relationship between the time spent on a subject and overall achievement (Schmidt, 1983).

Baker (1985) looks at middle school students, their achievement in science, and whether or not they have personality values, attitudes and abilities similar to those associated with scientists. The characteristics in question involve interest in ideas versus people, introversion, creativity, intuitiveness, a logical and analytical tendency, preference for order, an aesthetic appreciation of the world, good spatial and mathematical ability, and a positive attitude toward science. Some difference in attitude between sexes was found to exist.

> Males portray themselves as basing decisions on logical analysis, while females prefer to portray themselves as basing decisions on personal values. Males are slightly less introverted than females and they have slightly lower science grades and a less positive attitude toward science than females. (Baker, 1985, p. 107)

Males with high science grades believed they based decisions on logical analysis, valued a planned, orderly life, showed good spatial ability, but also had the most negative attitude toward science. Girls with high science grades also valued a planned, orderly life, but based decisions on personal values. They also showed a negative attitude toward science, and had poor spatial ability. Students with lower grades valued spontaneity and flexibility in their lives, showed poor spatial ability, and a tendency for negative attitudes toward science (Baker, 1985).

These results seem to indicate that females exhibit more science-related traits than males. When achievement is used as a comparative tool, the males with high grades had more of the characteristics associated with science. Attitudinal comparisons showed students with positive attitudes to be more introverted and intuitive and those with negative attitudes to have better grades and spatial abilities. The author offers as an explanation, that these patterns reflect the changes of adolescence, when students are deciding their futures and developing their personalities (Baker, 1985).

The findings imply that potential scientists can be identified early, based on their demonstration of science-associated traits. It also implies that because certain students lack some of these traits, they are not encouraged to pursue science.

This is further explored by Cannon and Simpson (1985) who feel that early experience and exposure to science affects science achievement and commitment. Achievement might depend on one's motive for success, the probability of success, and the incentive value that might be gained from it. It is also dependent on home and family background, environmental factors, the meaning one attaches to the stimuli provided, and the anticipated consequences of the responses. These factors may be responsible for the lower achievement of females, which tends to be viewed somewhat negatively when compared to males.

The study itself involved an examination of seventh grade life science students, their attitudes toward science, and their different achievement levels. With respect to science attitude, the beginning of the year showed students to be more positive than the end across gender and ability groups, with advanced males being the most positive. Both gender and differences across ability groups were not found to be statistically significant. However, significant differences were observed within ability groups for males at the general level and females at the advanced level (Cannon and Simpson, 1985).

Achievement motivation declined over the course of the school year, with females being more motivated than males. There were improvements in life science achievement from beginning to end of the school year, for all gender and ability groups, with no significant gains from the middle to the end of the year. Basic ability females showed greatest improvement throughout the year. The researchers found that achievement motivation did not play as significant a role in predicting achievement as did attitude and ability grouping. This was particularly true for differences in gender.

> Males had more positive attitudes toward science and achieved higher than females even though females were more motivated than males to achieve in science. These attitudes and behaviours may be due to gender role stereotyping in our society....Students with positive attitudes toward science will have a deeper appreciation and understanding of science and consequently achieve higher in science....(Cannon and Simpson, 1985, pp. 133-134)

Thus, it appears that achievement may have some contribution to the presence of girls in science, but not as an isolated factor. It is related to individual experiences, success, attitude, and ability group placement. It is also a contributing factor to gender differences in that old stereotypes still seem prevalent - girls are not encouraged to be high achievers, while boys are encouraged. This point of argument is addressed by Erickson and Erickson (1984).

Age, subject matter, and differential enrolment have been found to be relevant variables for sex and science achievement. While test score differences are not large, boys tend to outperform girls on science achievement tests. These differences tend to increase with age. There are also performance differences when the disciplines of science are considered. Boys excel in the physical sciences and girls in the biological sciences, as is reflected in U.S. enrolment patterns. Other variables to consider involve course objectives, in which boys appear to be somewhat more advanced in the areas of process and methodology (Erickson and Erickson, 1984).

The authors conducted research based on broad goals which encompassed understanding scientific knowledge, understanding the processes of science, application, safety, and scientific literacy in the content areas of biology, chemistry, physics, earth and space science (Erickson and Erickson, 1984).

In the area of understanding scientific knowledge and application, boys outscored girls increasingly across the three grades studied. The differences were small in biology, but tend to increase respectively in chemistry, earth science, and physics, especially for boys. Little change was observed for biology. No significant sex-related differences were seen in the area of understanding scientific processes, scientific literacy, and safety (Erickson and Erickson, 1984).

The authors propose two explanations for their results: the biological interpretation and the sociological interpretation. The biological interpretation focuses on the visual-spatial ability necessary for scientific thinking in the physical sciences. Since males supposedly have better developed spatial abilities, their success in physical science is a biologically-based advantage. "That is, sex-related differences in spatial abilities are said to result from innate differences in the nature or degree to which males and females use the left and right hemispheres of the brain for spatial processing" (Erickson and Erickson, 1984, pp. 74-75). Hence, brain lateralization is considered as an explanation for the observed differences. Brain lateralization and functioning is also thought to be affected by culture and training in that male sex-roles enhance the development of right hemisphere functions (spatial processing). This particular explanation is not completely accepted as a result of weak evidence for the relationship between science achievement and spatial ability, the small sex-related differences that have been determined, and the characteristics that distinguish physical sciences from biological sciences that require closer attention with respect to their link to spatial ability (Erickson and Erickson, 1984).

> The sociological interpretation argues that social and cultural forces work to create different experiences and expectations for girls and boys and to communicate to children what behaviours are considered to be sex appropriate. The different experiences and the masculine image of science and scientists contribute to providing boys with more relevant cognitive experiences upon which they can draw in science classes and more positive dispositions or attitudes towards science-oriented activities. (Erickson and Erickson, 1984, p. 76)

This can lead to the observation of boys experiencing greater success in electricity, chemical reactions, and mechanical objects. They also show selective attention to science-related activities and literature which serves to heighten interest and broaden their comprehension of abstract ideas in science (Erickson and Erickson, 1984).

The researchers admit that this interpretation and its consequences on girls' achievement is more difficult to assess but cannot be dismissed as futile. The Grade 12 students' responses were thought to be the result of the cumulative effects of the masculine image of science, early failures, and possibly greater exposure to physics teaching. Ultimately, these differences should be recognized as areas where changes can be implemented. The role of experience should be acknowledged and developed so as to compensate girls for their lack of experience (Erickson and Erickson, 1984).

A similar study was cited by Joan Scott at the workshop of the Science Council of Canada in 1982. She points out that girls do have a significant lack of experience in such areas as trying to find out how household mechanical things work, how industries apply science, the design and running of experiments. These early experiences may have some bearing on the later development of science concepts (Science Council of Canada, 1982).

Scott brings up another interesting perspective: there are far more male science teachers than female science teachers at the high school level. This may cause girls to perceive women as a minority in science and technical careers. They might feel that they are inappropriate, unwelcome, or even eccentric. Similar evidence was quoted at the workshop by Dr. Linda Fischer. She too, believes that boys get an advantage in science by exposure to science and science-related activities outside of school.

> A feedback loop is set up in which their initial interest is fed by school science and their growth in knowledge and interest is ahead of those with no initial interest. The increase in the lead of boys over girls from ages 10 to 14 is used as support for this. Sex differences in scientific achievement are reduced when girls have taken as many science courses as boys, if those courses are physics and chemistry....Early experience of science is likely to benefit high ability girls who are comfortable with male identified activities or who do not stereotype science strongly. (Science Council of Canada, 1982, p. 73)

Thus, we again see the effects of socialization to traditional sex role stereotypes. Achievement in science still appears to be encouraged for males but not for females. It is closely related to cultural upbringing, environmental factors, early exposure and experiences, attitudes, and motivation. Since students at school must deal with teachers, both male and female, it might also be worthwhile to examine whether achievement and attitudes are affected by the teacher as role model.

<u>The teacher as role model</u>.

This writer's personal experience has led to the belief that teachers do play some role in the decisions that are made by students and in the direction they choose in the future. Outstanding teachers and their qualities and characteristics always remain in the memory of a student who perceives them in that way. In this sense, the teacher has left his or her mark on that particular student. Similarly, science teachers might have some effects on their students. The following series of articles, arranged chronologically in order to identify any possible changes, will examine the effects that teachers can have on their students' attitudes, achievements and successes, and perhaps even on their future careers.

The first article deals with the effects of socialization toward stereotyped sex-role and its maintenance by classroom teachers. Females are faced with the expectation to conform to classical female roles, especially in high school where they are observed to opt out of certain academic areas. There is loss of motivation for academic interest and achievement and reinforcement for nurturing, obedience, and responsibility. Some studies show that women fear success and competition. The question of the extent to which the teacher, and his/her attitudes and behaviours, foster sex-role development is addressed by Ricks and Pyke (1973).

With respect to perceptions of behaviour and treatment, a majority of the teachers believed that differences did exist. Boys were perceived to be more active, but performed poorly, while girls were viewed as being more passive and performed better. It was noted that these results fit socialized stereotypes for males and females (Ricks and Pyke, 1973).

Teachers also believed that students expected differential treatment. Girls expect to be treated in ladylike, genteel manners with care and consideration of feelings. Boys expect sternness, authority, limitations, and establishment of rules. The teachers who treat the students accordingly may be shaping classical sex-role behaviour. Male teachers perceived that girls want "girl treatment" by a substantial majority. They may be contributing to female sex-roles by following through with the expectations (Ricks and Pyke, 1973).

In other areas examined, teachers had preference for teaching male students because they were perceived to be more outspoken, active, willing to exchange ideas, etc. Male teachers were thought to be more knowledgeable, authoritative, clear and direct. An overall negative attitude about the competence of women was also observed (Ricks and Pyke, 1973).

Overall, without further examination of attitudinal perceptions, the outcome of the study indicated that the perceptions and attitudes of the teachers were traditional, thus contributing, to some extent, to the socialization of the students toward the same beliefs.

If, in fact, science teachers have such an impact on their students, it would be helpful to identify some of the characteristics that make science teachers so influential. Welch and Lawrenz (1982) undertook the task of isolating characteristics of science teachers with the intention of obtaining a better understanding of the nature of their influence. An examination of the results indicated that distinct characteristic differences exist between male and female science teachers. Female teachers had higher scores on measures of science interest and receptivity to change; they showed more positive attitudes and were considered more knowledgeable about the processes of science than were male teachers. They also held different perceptions about support staffs and had less overall training and experience than the males in the study. Explanations for the observed differences were related to factors that lead women to science and that these factors may differ for females as opposed to males (Welch and Lawrenz, 1982).

This study, while identifying that male and female teachers have different characteristics, did not address how these differences affect students and whether or not they lead to suitable role models for the students. The perceptions of students of these teachers is addressed in another study by the same researchers.

Do students perceive their science classroom environment in significantly different ways depending on whether the teacher is male or female? The findings showed that,

> the students perceived classes taught by females as more diverse, goal-directed, and formal than classes taught by male teachers, while classes taught by males were perceived as more difficult than classes taught by females. Students also viewed classes taught by females as having significantly more friction and instances of teacher favouritism than classes taught by males. (Lawrenz and Welch, 1983, p. 658)

These results appeared consistently from junior high science to physics classes. Reasons for these perceptions might be linked to differential teacher characteristics (i.e., male teachers were more knowledgeable, hence their classes might be considered more difficult). On the other hand, females were considered to be more receptive to change leading to greater diversity in their classes. The positive attitude of female teachers did not seem to be reflected in the formality, goal direction, friction, and favouritism perceived by students in their classrooms (Lawrenz and Welch, 1983).

These classroom differences may be one of the causes of girls' movement away from science. If classes are perceived as difficult, this might increase their anxiety levels with respect to their success in such a class. The fact that there are far fewer female science teachers at the secondary school level lends further support to the belief that science is unfeminine and male dominated. There are few role models but when females do teach science classes, the issues of normality, goals, diversity, and favouritism are prevalent (Lawrenz and Welch, 1983).

Kahle (1983) investigated teaching strategies and teacher attitudes which encouraged girls in science. Due to the length of the discussion of the observations and results, a summary of the commonalities found to improve retention rate and achievement levels of girls will be offered here. These commonalities revolved around synthesis and analysis of teaching behaviours, classroom climates, instructional materials, and academic preparations.

The teachers themselves were active professionals; they provided career information and related biology to everyday life. They showed fair treatment and had fair expectations for both boys and girls. One negative aspect cited was that the teacher still held sex-role stereotypes that did affect classroom behaviours (Kahle, 1983).

The students were studied to determine the presence of girls' attitudes, levels of science anxiety and attendance in extra-curricular activities, and if their teachers had any positive influence on these factors. The students also had very traditional and sex-stereotyped views of their abilities. With respect to science careers, almost half of the males and females did not wish to pursue a career in science, citing such reasons as inadequate grades, excessive educational preparations, or lack of necessary background courses. A large percentage of both sexes received encouragement from their biology teachers to pursue higher education (Kahle, 1983).

In the classroom, girls had to participate as frequently as boys in question/response, group work, and experiment situations. Some gender differences were found in activities related to electricity, mechanics and astronomy, favouring greater participation by boys, in and out of school. Participation in projects, clubs, science fairs, etc. showed no gender differences. The case study females showed an equally positive attitude toward science as their male peers. This may have been a result of the case study teachers' influence and the experiences they allowed the students to have in their classes (Kahle, 1983).

The commonalities found, then, are as follows:

-teachers' classrooms were attractive, well-equipped and maintained;

-all used non-sexist teacher-developed instructional materials to supplement the basic text;

-all tried to treat boys and girls equally and fairly and used women scientists to impart career information;

-all presented "girl-friendly science," used more labs, discussions, and tests than usual;

-all had solid academic backgrounds, were respected and recognized in their communities, and received parental support;

-all participated and encouraged extra-curricular science activities;

-all emphasized careers and post-secondary education;

-all encouraged creativity, further education and basic skill development;

-all had positive attitudes, unique personality characteristics and teaching behaviours.

These commonalities led to a greater proportion of girls in their classes continuing in high math and science courses (Kahle, 1983).

It is interesting to note that this study focused on one group of teachers, biology teachers. It showed that the teacher can have some positive influence and effect on the students.

Another study of science teacher characteristics and student outcomes was conducted by Aiello-Nicosia, Sperandeo-Mineo, and Valenza (1984). The findings pointed to the conclusion that the ability to control variables and the understanding of science processes are related to student outcomes. They suggest that a working knowledge of the topics to be taught is necessary for teachers to be effective. They also suggest that science processes can be taught effectively if they can be performed (Aiello-Nicosia et al., 1984).

An examination of girls in non-traditional programs done by Yergeau (1988) suggests that science teachers can demonstrate the importance of science to certain careers and show that girls can do just as well as boys, if not better. This serves to increase girls' confidence in their own abilities.

She also cites some examples of teacher practices which discourage girls and their consequences on girls' future choices. For example, teachers have been shown to pay more attention to boys than girls during question/response activities. This serves to cause girls to question the value of their responses and hence does not help build confidence. Similarly, congratulating boys on their talent and girls on their effort and neatness transmits and reinforces stereotyped practices which may further discourage girls from science. On the other hand, practices which offer incentive to continue science study are available. An examination of the relationship of science to several careers and the use of modern female role models offers girls access to a range of career choices and presents concrete applications of the outcome of studying science (Yergeau, 1988).

It seems important for teachers to practice methods that will encourage girls.

> Identifying and eliminating practices which might prevent girls from enroling in such options (non-traditional careers) is essential....It is important to set up

> preferential measures for girls, in order to redress the effects of past discrimination. Support measures for the girls may also be set up. A program designed to encourage girls to pursue non-traditional careers could thus have a beneficial effect on a whole range of school practices: awareness activities, welcoming services, and support, placement and follow-up activities. (Yergeau, 1988, p. 65)

The idea of the use of more positive practices is also expressed by Bowyer (1988). Girls will develop a better outlook toward education and careers in science if,

> teachers avoid classroom practices that reinforce male stereotypes; an emphasis is placed on science-technology-society interactions to show science has a human dimension;...career counsellors make girls aware of the opportunities open to them in the science and technology field. (Bowyer, 1988,p. 22)

Cannon and Simpson (1985) recommended that science teachers represent strong influences in dispelling traditional views of gender role stereotyping. Males and females need to experience success and see the successes of females in fields of science and technology.

Ricks and Pyke (1973) recommend that teachers explore and confront their biases and misconceptions in an effort to begin to foster change. They suggest in-service teacher training and direct feedback after monitoring, as further methods to change the traditional views and hence open up opportunities for females in science.

To sum up, we observe that students are, in fact, affected by their teachers. Male and female teachers still appear to exhibit selective behaviour expectations from males and females, which may be contributing to the continuation of typical sex-role behaviour. It was also observed that "good" science teachers did impart a positive effect on their students. There is still a need for girls to be encouraged to participate more fully in lab activities, to be made to feel they are essential contributors to class discussions, and to experience success so that confidence in their own abilities can be nurtured and developed. Since they spend so much time with their teachers of science, that may be the place to begin this type of change.

Having done an overview of the related variables, the following section will focus on some of the issues and problems that females must face in the field of science and technology. These fall under the guise of implications to science as a future for females.

C. Implications

Issues and Problems

The Hamilton Spectator ran an article in April of 1990 entitled "Solving Canada's Science Crisis." In it, William Cade (Brock University) states that there has been a decrease in science enrolments in post-secondary education. Furthermore, many scientists are reaching retirement age and need to be replaced by new, younger scientists. Since white males now show greater tendency toward business and other fields rather than science and technology, Cade suggests we look to females as the replacement population for the retiring scientists. He quotes,

> in mathematics and the physical sciences such as chemistry and physics, women represent only 15.9% of the new Ph.D.s. Women are also poorly represented in undergraduate programs in these

> studies....The biological sciences have more women that the other sciences, but even here make up only 29% of new doctoral graduates compared with 61% in psychology and 54% in education. (Cade, 1990, p. A7)

It seems then, that women need to be encouraged into science much earlier than post-secondary school.

Cade's comments are a reflection of one particular institution at present. An examination of past issues is needed in order to determine if anything has actually changed. This review has already discussed the early beliefs about women, their abilities, or lack of them, and the resultant theories of why women could not participate in science. These theories ranged from physical danger to biological reproductive structures, to brain lateralization, to the effect of hormones. They also focused on societal expectations and traditional beliefs about women. It was observed that while many of the theories were eventually disproved, those relating to women's abilities and society's expectations still seem to prevail.

White (1970) cites the conflict faced by women with professional and familial obligations and the problems of identity, and self-esteem. One of the main barriers to achievement and success that women face revolves around the expectation that their careers will emulate those of men in that particular field. Any interruption (marriage, motherhood) are perceived as failures. Further to this, females are not encouraged to be proteges of male scientists. They are not always privy to that period of "internship" whereby knowledge about institutions, journals, professional meetings, grant funding, etc. is obtained. Women seem to be excluded from informal channels of communication, from signs of belonging, and recognition.

Hardin and Dede (1973) discuss examples of sexism in science education that may serve to further limit the participation of females in science. They propose that sex biased encouragement not only occurs in educational institutions but as a result of societal forces outside of formal education too. Among the non-school forces is the lack of role models and adult examples. Furthermore, the few female scientists who exist as role models may serve to reinforce the idea that science is a difficult area for women to experience excellence.

The authors also cite the opportunity to be selected as proteges.

> A well-recognized scientist is less likely to choose a woman as his protege,

> regardless of ability - because he is less sure that she will pursue a vertical path of achievement and thus reflect success back on him and he may fear that others will read sexual implications into his special attention to a woman. (Hardin and Dede, 1973, p. 19)

Sex-role stereotyping is thought to go back to early childhood, when different toys are offered to boys (cars, trains, construction sets) and girls (dolls, tea sets, toy ovens, crafts). Even story books can expose children to expected sex roles and this continues within the schools. With respect to expectations, society believes there are intrinsic differences between boys and girls. Boys are thought to be analytical, mathematical and logical; girls are less analytical, more verbal and more intuitive. "The key to the matter seems to lie in whether, and how soon, a child is encouraged to assume initiative, to take responsibility for himself, rather than rely on others for the direction of his activities" (Hardin and Dede, 1973, p. 19).

In school, boys and girls receive rewards and admiration for sex-specific or appropriate behaviours. Sometimes the girls deviate from the norm and emulate boys' behaviours, only to be called tomboys. This sorting of behaviours continues in junior high. The greatest sex differences occur between the ages of nine to fourteen. Here interest and achievement decline. Girls are also outnumbered by boys in their science classes and are counselled to pursue languages rather than science. Finally, girls put much emphasis on boyfriends and their accomplishments as opposed to their own (Hardin and Dede, 1973).

Three similar factors that serve as barriers to females were cited by the National Science Teachers' Association (NSTA) in 1974. These three factors are:

> -the range of student-used materials and the way the gender roles of those involved in science are portrayed;
>
> -the role of the guidance counsellors to inform students about career options and requirements and to help them develop their abilities to the fullest;
>
> -the encouragement and guidance toward achievement and careers in science provided by the teacher (NSTA, 1974).

The NSTA emphasized the need for teachers to eliminate sex-role stereotyping and present males and females in an equal ratio in instructional materials. Teachers must also urge equal treatment of males and females by counsellors, when career options are being considered. They should keep counsellors informed of the progress, abilities, and interests of female students. Furthermore, "science teachers must consciously strive to overcome the barriers created by society which discourage women from pursuing science for its career opportunities and the enjoyment of brings to involved students" (NSTA, 1974, p. 34).

Burfoot (1986) states women are headed toward social and community sciences as opposed to physical science and technology occupations. She feels that girls choose careers that will maximize their ability to drift in and out, and girls who do enter science-related studies tend to choose biology and applied sciences.

> The cause of this early, partly self-determined segregation is due to women's aptitude (in terms of preparation), attitudes, and aspirations as well as the possibilities offered to them. Thus current science and technology education fails to recognize the different life experiences of women as well as their

> divergent interests and so acts as a deterrent to women choosing a career in science or technology. (Burfoot, 1986, p. 76)

This points to science education itself as another means to improve the situation for girls in the field of science.

Zuckerman and Cole (1985) propose the Principle of Triple Penalty as an explanation for the absence of women from science and engineering. The principle offers three barriers that inhibit women from becoming productive scientists.

> First, science is culturally defined as an inappropriate career for women; the number of women recruited to science is thereby reduced below the level which would be obtained were this definition not prevalent. Second, those women who have surmounted the first barrier and have become scientists continue to be hampered by the belief that women are less competent than men....It contributes to women's ambivalence to their work and thereby reduces their motivation and commitment to scientific careers. Third,

> there is some evidence for actual discrimination against women in the scientific community... (Zuckerman and Cole, 1985, p. 84)

To expand on the above, the authors offer numerous examples of women, their beliefs, achievements and resulting consequences, examples of which follow. Since women feel they are unqualified for science and engineering careers, they do not invest the time required for proper training and settle for occupations that satisfy their perceived abilities. Families have greater willingness to educate sons than daughters, thus contributing to the ambivalence of females. Women obtain postgraduate degrees two years later than men, partly due to marriage and motherhood. It is also believed that women scientists have much less to contribute, and publish fewer papers than men. This has even been attributed to being inversely proportional to the number of children a woman scientist has! Finally, women scientists, being supposedly less motivated and less productive, receive fewer job offers and often lower salaries (Zuckerman and Cole, 1985).

The objective, then, is to overcome the obstacles preventing a breakthrough into the scientific realm of work. The question remains, "How can this be achieved"? It is necessary for women to recognize their failures and successes as scientists, not as women. They need a greater amount of opportunities and an even greater need for recognition and feedback. An even larger obstacle remains the fear of the consequences and even loss of prestige that will be experienced by the scientific profession should women be allowed to dominate (Zuckerman and Cole, 1985). Hence, it seems the change required is almost unobtainable because of the extensive time it takes to affect societal change.

The lack of opportunity for women scientists is further substantiated by Weis (1987). She reports that while there was an increase in the number of women in scientific and related fields from 1977 - 1984 (based on National Science Foundation data), many women were still not being employed in a full-time capacity. Women still are under-represented as university professionals in science, 15.6% in 1977 and 20.4% in 1984, with their areas of expertise being the social sciences, psychology and life sciences. There may be a "ceiling" for women in those faculties which are generally dominated by men.

There was a substantial increase in the number of women who worked in the areas of mathematics and computer sciences. This could be a reflection of higher demands by the private sector. There might be a lack of trained men or a willingness to hire women. "The increase in female hiring may, unfortunately, reflect even more severe discrimination by gender in the private sector and a willingness of women to work for less" (Weis, 1987, p. 44). Overall, women have improved in obtaining bachelor degrees but continue to fare poorly when it comes to obtaining and succeeding in professional positions.

To summarize, certain issues and problems seem to stand out. Although there is a need for improved teacher accountability to help reduce and eliminate bias in materials and in classroom behaviour, it is not the most important issue. The most important issues seem to lie in misinformation, especially during adolescence. Adolescents experience so much change during their first few years of high school. At the same time they are responsible for making educational decisions that will have consequences on their futures. However, they come to high school with fears and apprehensions and must further contend with myths, about science for example, which society puts forth to them. They have a lack of information, a lack of positive effective role models, few rewarding experiences. They must deal with peer pressures, the pressure of some male-dominated science classes and eventually discrimination in the workforce.

With respect to females, they must deal with societal and parental expectations to conform to sex-appropriate behaviours, teacher expectations which often only reinforce female sex-role behaviours, guidance counsellors who direct them to service-type or language-type occupations as opposed to science and technology occupations. Science education does not recognize or meet the needs and interests of female students.

In the workplace, females must contend with conflicting responsibilities of professional and homemaker. They tend to work for less pay, receive fewer offers of improved employment and are generally less recognized for their achievements. These are the important issues that must be met and resolved in order to offer girls a more promising future in science and related fields.

CHAPTER THREE: METHODOLOGY

Overview

This study lent itself to a mixed quantitative and qualitative design, mainly due to the scope of the project. The data were gathered primarily by means of questionnaires and the author also made use of some documentary material available about the topic at the Ministry of Education.

Research Design

In this design, several research variables were considered. They were:

a) demographic information (age, sex, nationality);
b) home characteristics;
c) perceived socioeconomic background (parental occupations);
d) attitudes toward science;
e) achievement (overall grades);
f) teachers as instructors, attitudes towards teachers;
g) perception of the usefulness of science.

These could all be considered intervening variables for the purposes of this work. The independent variable would appear to be the motivation behind the enrolment, or lack of it, in science courses. Science course enrolment is the dependent variable.

Also important were the confounding variables. Such factors as age, sex, ethnic background, genetic predisposition, intelligence could not be controlled but could effect the results of the study. One must also consider the willingness of the groups to respond to the questions, the relative equivalence of the groups in the areas of intelligence, maturity, and readiness.

These variables were examined by means of a questionnaire. This questionnaire was administered to several groups of students enrolled in advanced level science courses in seven high schools belonging to the separate system. It was predicted that there would be at least 150 available students at each of the seven schools resulting in a population sample of 850. In fact, the number was closer to 200 students per school and the final sample was 1,345 (based on the outcome of the analysis of the Scantron cards).

Further data on male and female enrolment were obtained by gaining access to Ministry September Reports, kept in individual schools, at the local board, and at the Ministry of Education, Information Resources and Analysis, Policy Analysis and Research Branch. The data were divided into such areas as subject enrolment, level of study, and male/female statistics for each subject. Therefore, such reports provided the basis for the comparisons between male and female science course enrolment for the schools being considered.

A formal letter of request was sent to the appropriate branch of the Ministry of Education asking for this type of information. The contact person was the chief statistician, who sent a preliminary package of information and provided an invitation to go to the office to review any other material that might be pertinent to this study. The information for course enrolment was kept on computer microfiche. Copies of this data were obtained which went back to 1986, since that was the supposed point at which male/female figures began to be recorded. Information for enrolment before that date was also obtained but, unfortunately, this was not recorded by gender. Examples of this data are located in Appendix A.

Once all data were obtained, frequencies and chi-square, appropriate to the response scales used in the instrument, were applied.

Pilot Studies

A completely original questionnaire was developed in order to obtain information on the students taking advanced-level science courses in the schools of interest. It was quite useful to conduct a pilot study using a similar sample group. This group consisted of two advanced-level science classes, with a total population of 51. There were 19 male students and 32 female students, ranging in age from 13 to 17. This facilitated the determination of content validity, as well as aided in the identification of problem areas or questions. This was done prior to the actual study of the large sample, in November, 1990. A copy of the questionnaire used in the pilot can be seen in Appendix B.

Selection of Subjects

This study was conducted using seven groups of students from schools belonging to a separate school board in a large southern Ontario district. The emphasis was on students from Grades 9 through OAC, enrolled in advanced level science courses. Although the population was large enough, the process of randomization was not used.

Instrumentation

To obtain more information on the motivational factors that influence science course enrolment, a large sample of students were asked to respond to a number of questions and statements on a questionnaire. Such areas as demographics, home characteristics, perceived socioeconomic background, attitudes toward science, achievement, attitudes toward teachers as instructors, maturational differences, and perceptions of science usefulness were examined on this questionnaire.

Upon perusing some of the literature, some questions were developed based on similar questions which were used in similar studies. Their appearance in the actual test instrument was modified, and they were accompanied by appropriate response scales. These were Likert or Likert-type scales, with assigned letters, to be completed by the respondents by means of filling in appropriate corresponding bubbles on Scantron sheets. This facilitated the accumulation of the data for statistical analysis.

Questions and statements were compiled to cover all the areas of interest previously mentioned. The questions were narrowed down to make the questionnaire a manageable length.

Data Collection

Data collection was initiated by means of the distribution of a formal letter of request to appropriate members of the school board, requesting permission to conduct the study using advanced level students at the seven schools in the board district. The Board's clinical psychologist granted permission in February, 1991. To inform the individual schools of the intent of this study, and to request their much needed participation, similar letters were sent to the school principals and to the science department heads of each school. These people served as contacts for the remainder of the data collection process and were very positive and helpful.

An explanation of the study and instructions for the distribution and use of the questionnaires were included in subsequent correspondence. The questionnaires were sent by means of the board courier. Then, they were administered by the individual classroom teachers over one class period, collected by the same teachers, and returned to the department heads. The department heads then returned the packages by courier, once again. The whole process, which was expected to take one week, ended up requiring three weeks by the time all of the questionnaires were returned. This method proved to be fairly successful overall in that the departments heads were able to explain the questionnaire and its instructions to the teachers individually. The teachers, for the most part, were extremely diligent and careful in the administration of the questionnaire.

There were a few minor difficulties encountered nonetheless. At one school, which made use of two campuses, only the west campus students responded to the questionnaire. The east campus did not receive the package, as it was returned, presumably by the department head, who must have chosen not to take it over to the other campus. This might have been corrected by setting up two separate sets, one for each campus. Since the number given reflected the total number of advanced level students at that school, this would have been difficult just the same.

At another school, approximately 30 questionnaire response sheets were completed in ink, making them virtually useless. This was corrected by completing new cards, with the identical responses, in pencil. This eliminated the need to discard those responses from the large sample.

At yet another school, the department head did not insist on the completion of the questionnaire by all of the advanced level science students. Two classroom teachers refused to administer the questionnaire to their classes, for reasons undisclosed to this researcher. This only led to a slightly smaller representative sample from that school.

In addition, the department heads provided figures for student enrolment in advanced science classes. The sample was expected to be about 2,500. At the end, the sample was 1,345, a little over half of the expected sample. The only explanation for this difference is that the numbers provided were a reflection of the entire school year's enrolment, rather than only that of the second semester.

Overall, the process went smoothly and the students completed their part of the project willingly. The large sample study was conducted in April of the second semester of the 1990-91 school year. Students were assured complete anonymity by means of an opening letter which gave them an explanation of the study, what was expected, and the opportunity to refuse to complete the survey. Information known about them as individuals was their gender, their ethnic background, their present grade level, and the school in which they were enrolled. This encouraged greater participation and more willingness to respond to the items on the questionnaire with honesty and candour.

The Likert scales on the questionnaire were examined and total frequencies were accumulated to determine if the results were close to those expected for each question. Following this, a chi-square analysis was conducted to determine significant gender responses.

Statistical Analysis

Once the data were collected, the section of the questionnaire that did not appear on the Scantron sheets was analyzed by hand. The questionnaires were divided, by school, into male and female response groups. A tally sheet was developed which incorporated the pertinent sections and used to tally the responses. Percentages were then developed and appropriate tables were designed to highlight possible response patterns. These will be discussed in greater detail in Chapter Four.

The Scantron sheets were analyzed through the Computer Department at Brock University. The cards were initially scanned, then analyzed for frequency of response by school, and for overall gender comparison by means of the chi-square test. This allowed for more accurate descriptions of changes and trend patterns of responses for each school and for the entire sample being considered. Furthermore, the chi-square was used to bring out those factors which may have been systematically related to gender and whose relationship transcended pure chance or error. That is to say, some responses showed a definite pattern because of the type of question and the factor that was being measured.

The use of these simple statistical tools provided the necessary quantitative data for this study. They were determined by the sample size (N = 1,345) in order to identify the underlying motivational factors behind questionnaire responses. These analyses were used to determine trends in enrolment to highlight which, if any, motivational factors played a significant role. This would permit a discussion of practical intervention strategies and techniques to promote science course enrolment.

Methodological Assumptions

Some methodological assumptions that were made include:

a) the instrument being used was valid and reliable;

b) all respondents understood the instructions and the components of the questionnaire;

c) all members of the sample would respond;

d) the population was selected without bias;

e) the sample was large enough to allow generalization;

f) the students understood the seriousness of the survey;

g) the time frame provided was adequate for response and return of the questionnaires.

Summary

Some specific details about the means by which this study was be conducted have been outlined above. Once all the steps were completed, analyses and interpretations of the findings were made. The data obtained will be discussed based on the design of the questionnaire, the motivational factors being considered and the objectives and questions outlined earlier in the paper.

CHAPTER FOUR: FINDINGS

The data were collected and statistical analyses performed over a two-month period of time. It has been arranged as findings in appropriate tables, graphs, and charts. Each has been further enhanced by the use of descriptive prose to summarize inferences, highlight trends and patterns, provide interpretations and subsequent suggestions for changes and/or improvements. The evidence relates back to the original purpose and objectives. The findings are also used to provide answers to the research questions posed.

The Pilot Study

The demographics section of the questionnaire was rather lengthy, therefore, steps were taken to shorten the realm of possible responses to those which appeared most often in the pilot. Many of the questions were re-written to make them applicable to the choices available on the Scantron sheets. This also facilitated the accumulation of statistics and allowed for a better comparison of the gender responses.

As a result of the pilot, a few minor changes were made to facilitate the large sample study. The questions, in each of the sections, were numbered sequentially throughout the questionnaire, rather than starting anew at the beginning of each section. The questions numbered 104 which could be answered using the Scantron sheets. The options for response were only altered so that there were no more than five possible choices to each question. This made use of the Scantron sheets more appropriate and actually served to shorten the length of time required to complete the questionnaire. There were seven questions in the demographics that were left as short-answer questions due to the nature and scope of possible responses. They covered ethnic background, parents' occupations, favourite subject, favourite teacher and reasons for the choice, and identification of the science courses in which the students were enrolled. The results of these questions were tallied and tabulated by hand and expressed as percentages of the sample. All other questions were analyzed by computer.

The Large Sample Study

Introduction

Once the questionnaire was re-organized based on the required changes highlighted earlier, it was distributed to the large sample. Preliminary figures provided by the science department heads at each of the seven schools, indicated a population of over 2,500. The questionnaires were photocopied, Scantron purchased, and packages for each school were prepared for distribution. Each was accompanied by letters to the students seeking their participation, as well as instructions to the teachers for the administration of the questionnaire. A revised copy of the questionnaire can be seen in Appendix C.

To re-establish the nature of the sample being studied, a summary of the schools being considered may be useful. The schools were all a part of the Hamilton-Wentworth Roman Catholic Separate School Board. There were seven schools consisting of Bishop Ryan High School, Cardinal Newman High School, Cathedral Boys' High School, Cathedral Girls' High School, St. Jean de Brebeuf High School, St. Mary's High School, and St. Thomas More High School. In order to have a neater comparison of gender, the Cathedral Boys' and Cathedral Girls' High Schools were combined into one. Some abbreviations appear in the tables and graphs which should also be introduced here. Bishop Ryan will be referred to as BR; Cardinal Newman will be referred to as CN; the Cathedrals will be referred to as Cath.; St. Jean de Brebeuf will be referred to as S.J.B.; St. Mary's will be called St. M.; and St. Thomas More will be called S.T.M.

The discussion of the findings of the large sample study will be divided into sections in order to present a cohesive, organized summary. The sections will include:

i) Enrolment Patterns

a) Combined school enrolments.

b) Enrolment by gender.

ii) The Sample.

iii) The Questionnaire.

a) Demographics.

b) Science and science-related experiences.

c) Science abilities and attitudes.

d) Women in science.

e) Importance of science skills.

f) Image of scientists.

iv) Summary of the Chapter

The analysis was conducted in order to yield percentages, frequencies, and chi-square values. The frequencies highlight those responses chosen most often , but are not separated by gender. Since the study is an examination of factors influencing gender, the chi-square analysis was performed to obtain the male/female comparisons and to identify those factors which were of significance.

i) Enrolment Patterns

Earlier in this chapter, a number of questions were asked, directly related to enrolment. Two questions were:

a) What is the pattern of enrolment in science courses for males and females over the last ten years?

b) Has there been any overall change in the number of females continuing to study science over their entire secondary school education?

When these questions were first developed, the Ministry of Education contact ensured the researcher that the gender data were available for at least this period of time. As it turned out, it was available only from 1986 to present. This created a problem because it would be difficult to identify trends or patterns with only three years worth of information. To rectify the problem, the Ministry contact, now a different person assigned to the statistician position, was again contacted in the hopes that data for 1989 and 1990 could be obtained. This proved to be difficult due to a change over from data on microfiche to data on computer, which was not yet complete or available. Hence, the most recent data were not available at the time of this writing. Nonetheless, some of the enrolment data were provided and can be described. While it may not provide a definitive answer to the two questions, some inferences may still be applicable.

a) <u>Combined school enrolment</u>.

Due to the nature of the study, it was useful to examine the enrolment of the schools by combining them. Thus, the discussion will begin by examining a table which shows the cumulative enrolment of the high schools for a 13-year period. These data were obtained by summing the enrolment of each of the seven schools. It is important to note that these data are not broken down into gender nor are they presented by science course enrolment. They merely provide a picture of the overall enrolment of the board.

Table 1: A Summary of Student Enrolment - Combined Schools shows the total enrolment for the Hamilton-Wentworth Roman Catholic Separate School Board (hereinafter called HWRCSSB). It spans a range of 13 years and is divided into intermediate (9-10) and senior (11-13) levels. An examination of the column showing the total enrolments reflects a number of fluctuations. There was a slight decrease in enrolment from 1976 to 1978. This was followed by a gradual increase in enrolment from 1979 through 1985. Another marked decrease

Table 1

A Summary of Student Enrolment - Combined School and Subjects

Years	(9 - 10)	(11 - 13)	Totals
1976	3103	2526	5629
1977	2787	2417	5204
1978	2477	2075	4552
1979	2632	2066	4698
1980	2848	2061	4909
1981	2839	2045	4884
1982	2845	2319	5164
1983	2770	2493	5263
1984	2939	2579	5518
1985	4345	1348	5693
1986	3092	1638	4730
1987	3020	2285	5305
1988	3135	3580	6715

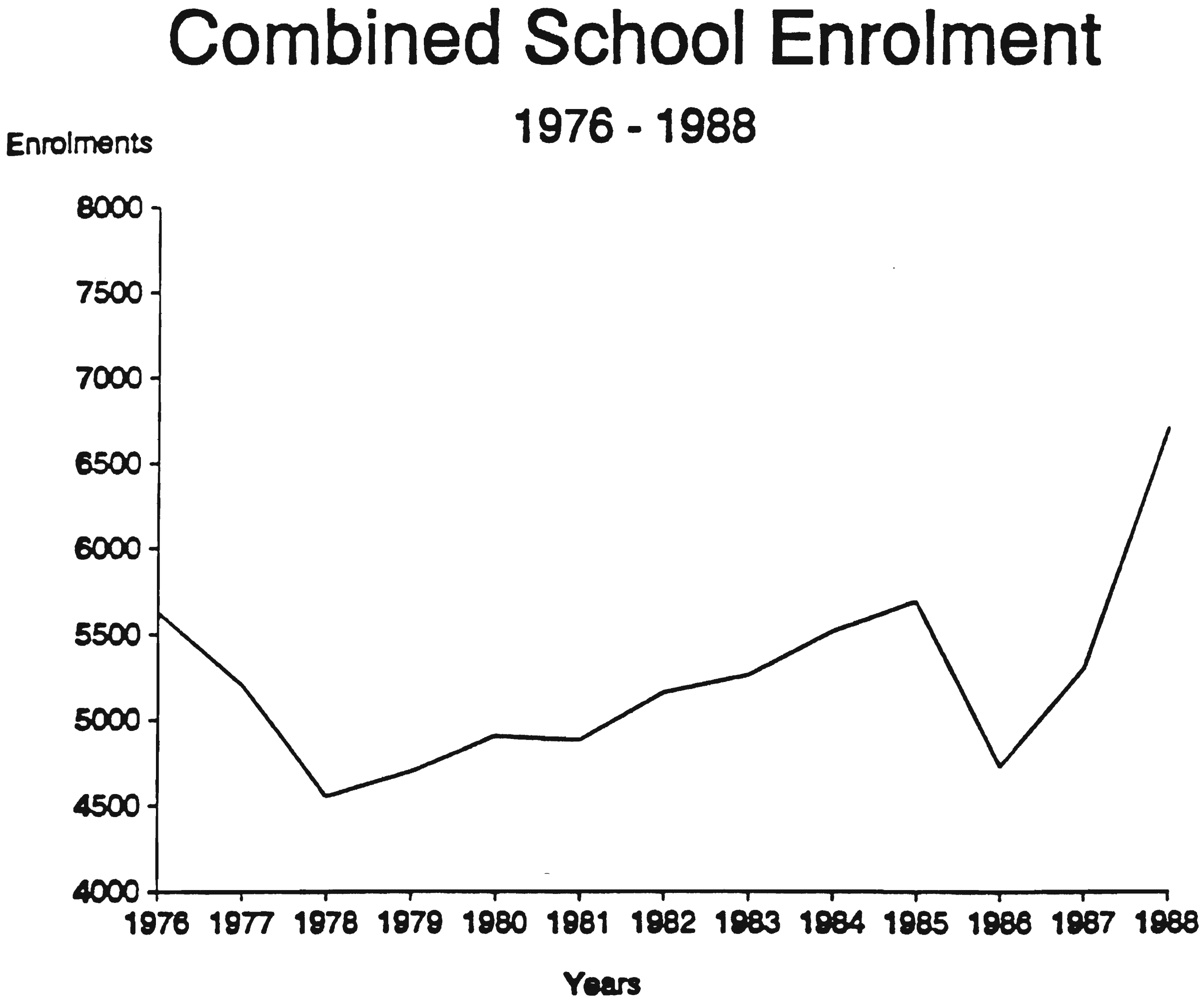
occurred in 1986. This may be attributed to a smaller population of Grade Eight students entering the separate system or a larger population of students opting for a secondary school education with the public system. Beyond 1986, an increase in enrolment again occurred. These fluctuations are also depicted on Graph 1: Combined School Enrolment 1976 - 1988 located in Appendix E. The graph gives a pictorial representation of the fluctuations in enrolment described from the numbers in Table 1.

Overall, the figures show that the enrolment never decreased below 4,502 (1978) and reached as high as 6,715 (1988). It might have been a useful comparison to obtain similar data for the local public system to determine if there were similar fluctuations in any given year, bearing in mind that the public system is comprised of a larger number of schools. However, that was beyond the scope of this study at the time. It would also have been useful to have the most recent enrolment figures, that is for 1989 and 1990, to determine if the overall enrolment continued to increase.

Some of the enrolment fluctuations were mirrored in the science course enrolment for the schools in question. The data available from the Ministry were for senior science courses, that is, courses offered from Grades 11 through 13. In 1976, senior science course enrolment was 2,783. A steady decrease in enrolment in senior science took place after that with

Graph 1

Combined School Enrolment 1976 - 1988



numbers decreasing to 2,230, 2,229, and 2,181 for 1977, 1978, and 1980. There were no data available for 1979. In 1981, there was the beginning of an increase in science course enrolment with numbers of 2,210 in 1981, 2,410 in 1982, 2,544 in 1983, and 2,638 in 1984. The most significant fluctuation in senior science course enrolment occurred in 1985, when the enrolment dropped to 1,387! The only reasonable explanation for this marked decrease would be that changes in curriculum and course requirements for graduations were implemented at that time possibly leading to a decrease in the number of students enrolled in science courses. (The figures presented here were compiled by taking the sums of figures available for each school as presented in Table 11.05 Course Enrolment by Division from the Ministry of Education microfiche files.)

To summarize, a pattern of change for males and females could not be identified due the absence of such data from the Ministry of Education. Because of this, the question involving the pattern of enrolment in science courses for males and females over the last ten years could not be effectively. Suffice to say that until course requirements for graduation with a secondary school diploma were changed making two the minimum number of science courses required, the enrolment in science appeared to be increasing.

b) <u>Enrolment by gender</u>.

It was of greater interest to examine those figures of science enrolment that were available divided by gender. They have been presented in Table 2: A Summary of Science Course Enrolment by Gender 1986 - 1988. The table was designed to highlight male and female enrolment in all three disciplines of science - Biology, Chemistry, and Physics - at the senior level, as well as intermediate level science. This has been presented for each discipline and school, by year. The table, therefore spans three pages. This made patterning of trends somewhat easier and allowed for the gender enrolment to be expressed as percentages.

For the 1986 school year, the figures indicate a slightly higher population of females in all of the disciplines, except for Physics, in which the male enrolment was markedly higher at all of the schools. In 1987, female enrolment was also higher than that of the males with a few exceptions. At S.J.B. the male enrolment in Chemistry was higher than that of the females, 52.55% versus 47.45%. At S.T.M., the split was exactly half, at 50% each. For Physics, female enrolment surpassed that of the males, 57.14% versus 42.86% respectively. In 1988, similar trends appeared. There were generally more females enrolled in science than males, again with some exceptions. Two schools, BR and St. M. had higher

Table 2

A Summary of Science Course Enrolment by Gender 1986 - 1988

	School	Course	Total	Males	Females	% Males
1986	BR	Science	343	158	185	46.06%
	CN		246	108	138	43.90%
	Cath.		306	126	180	41.18%
	S.J.B.		377	177	200	46.95%
	St. M.		167	71	96	42.51%
	S.T.M.		388	215	173	55.41%
	BR	Biology	94	36	58	38.30%
	CN		315	142	173	45.08%
	Cath.		48	0	48	0.00%
	S.J.B.		90	40	50	44.44%
	St. M.		55	26	29	47.27%
	S.T.M.		94	37	57	39.36%
	BR	Chemistry	92	36	56	39.13%
	CN		107	52	55	48.60%
	Cath.		72	20	52	27.78%
	S.J.B.		95	54	41	56.84%
	St. M.		33	13	20	39.39%
	S.T.M.		107	44	63	41.12%
	BR	Physics	83	43	40	51.81%
	CN		148	82	66	55.41%
	Cath.		54	40	14	74.07%
	S.J.B.		92	49	43	53.26%
	St. M.		38	23	15	60.53%
	S.T.M.		97	60	37	61.86%

Table 2 continues

Table 2

A Summary of Science Course Enrolment by Gender 1986 - 1988

	School	Course	Total	Males	Females	% Males
1987	BR	Science	333	153	180	45.95%
	CN		487	221	266	45.38%
	Cath.		278	107	171	38.49%
	S.J.B.		390	174	216	44.62%
	St. M.		322	159	163	49.38%
	S.T.M.		404	187	217	46.29%
	BR	Biology	130	36	94	27.69%
	CN		121	37	84	30.58%
	Cath.		128	22	106	17.19%
	S.J.B.		181	64	117	35.36%
	St. M.		133	43	90	32.33%
	S.T.M.		153	51	102	33.33%
	BR	Chemistry	170	84	86	49.41%
	CN		338	151	187	44.67%
	Cath.		143	57	86	39.86%
	S.J.B.		196	103	93	52.55%
	St. M.		140	64	76	45.71%
	S.T.M.		246	123	123	50.00%
	BR	Physics	143	88	55	61.54%
	CN		44	28	16	63.64%
	Cath.		63	27	36	42.86%
	S.J.B.		115	76	39	66.09%
	St. M.		46	29	17	63.04%
	S.T.M.		130	72	58	55.38%

Table 2 continues

Table 2

A Summary of Science Course Enrolment by Gender 1986 - 1988

	School	Course	Total	Males	Females	% Males
1988	BR	Science	327	151	176	46.18%
	CN		505	236	269	46.73%
	Cath.		283	106	177	37.46%
	S.J.B.		418	192	236	45.93%
	St. M.		333	166	167	49.85%
	S.T.M.		389	167	222	42.93%
	BR	Biology	189	70	119	37.04%
	CN		160	43	117	26.88%
	Cath.		125	24	101	19.20%
	S.J.B.		162	47	115	29.01%
	St. M.		144	69	75	47.92%
	S.T.M.		209	73	136	34.93%
	BR	Chemistry	189	103	86	54.50%
	CN		236	114	122	48.31%
	Cath.		69	27	42	39.13%
	S.J.B.		166	75	91	45.18%
	St. M.		137	75	62	54.74%
	S.T.M.		156	73	83	46.79%
	BR	Physics	74	48	26	64.86%
	CN		134	78	56	58.21%
	Cath.		49	35	14	71.43%
	S.J.B.		61	31	30	50.82%
	St. M.		51	30	21	58.82%
	S.T.M.		108	69	39	63.89%

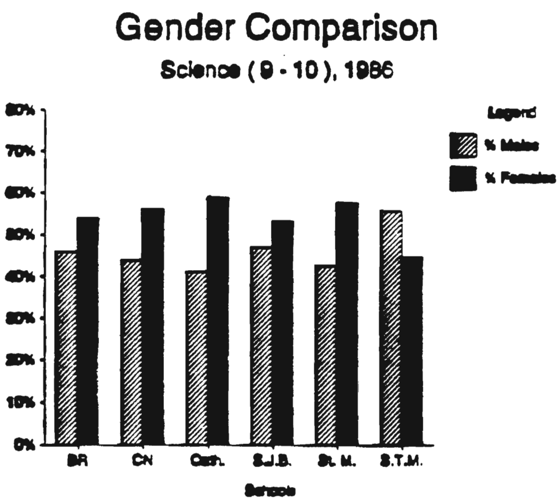
male enrolment in chemistry, while all the other schools showed much higher female enrolment.

Overall, the trends shown over just the three years of data would indicate that females tend to have a preference for Biology and that males prefer to study Physics. The interesting point is that Chemistry seems to have become more attractive to the females, more so over Physics. The trends are further highlighted by Graphs 2 to 13. These bar graphs present a comparison of male/female enrolment in Intermediate science, senior level Biology, Chemistry, and Physics. They show the percentages from Table 2 in a perspective that allows one to see the development of the inferred trends in enrolment and also allows a school-by-school viewpoint.

For Science (9-10), Graphs 2 through 4 show the highest percentages of female enrolment, except at S.T.M. in 1986 when male enrolment was higher. The two courses at this level are the mosaic introductory courses designed to provide opportunities to study all three disciplines of science. These courses are usually the first two taken to meet the requirements for graduation. For Biology, offered at the Grade 11 and OAC levels, the pattern of much higher female enrolment is easily observed for all of the schools being considered. This holds true for 1986 through 1988 and can be seen on Graphs 5 through 7. Chemistry probably shows the most fluctuation in that in some cases, at BR, CN, Cath., SJB, and

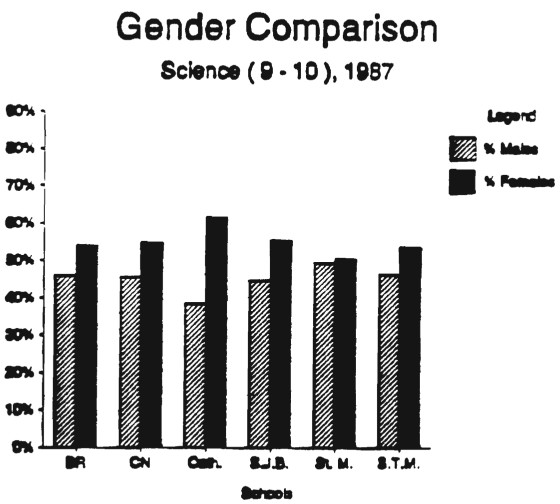
Graph 2

A Gender-based Summary of Science Course Enrolment 1986



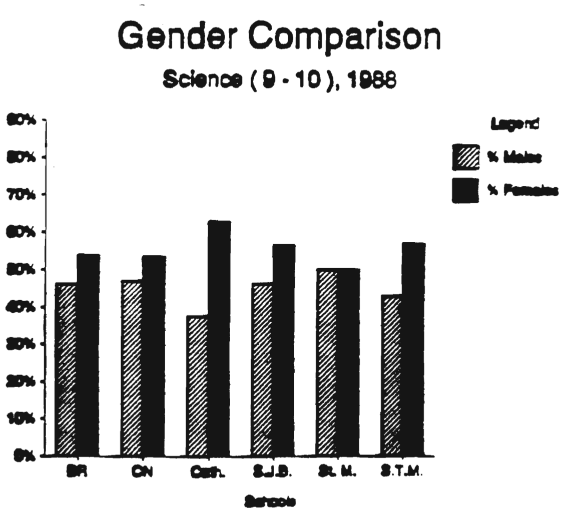
Graph 3

A Gender-based Summary of Science Course Enrolment 1987



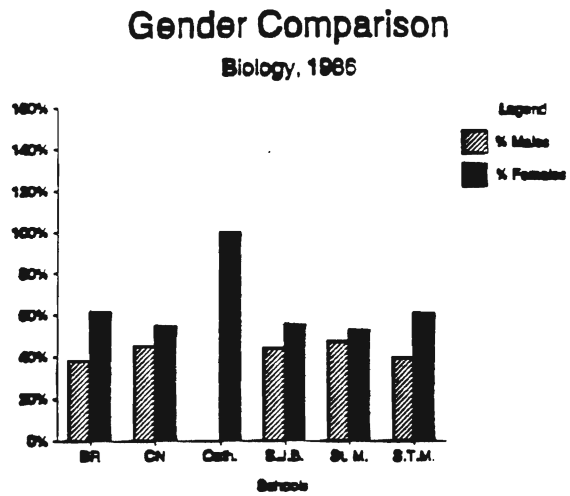
Graph 4

A Gender-based Summary of Science Course Enrolment 1988



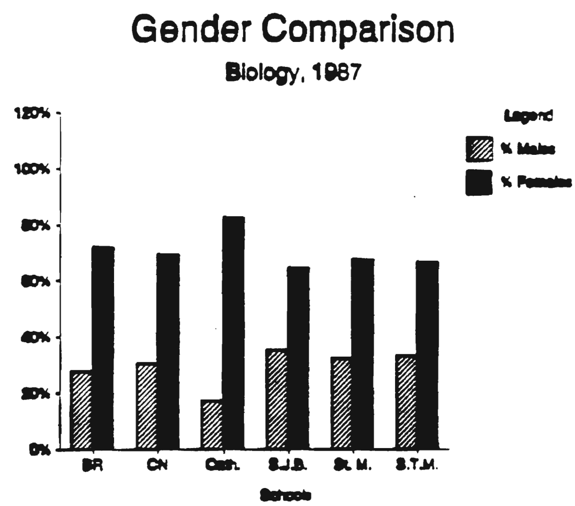
Graph 5

A Gender-based Summary of Enrolment in Biology 1986



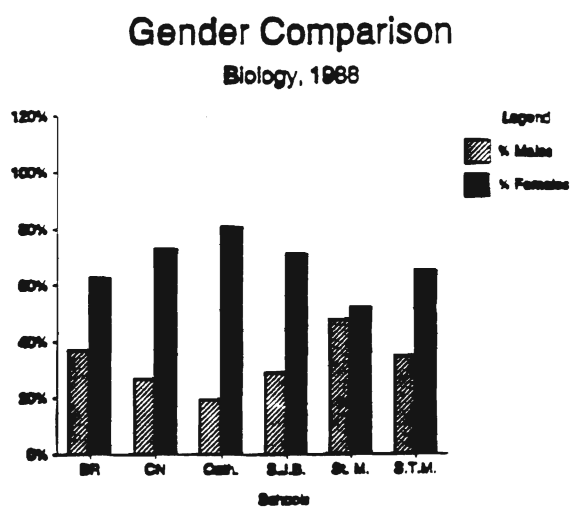
Graph 6

A Gender-based Summary of Enrolment in Biology 1987



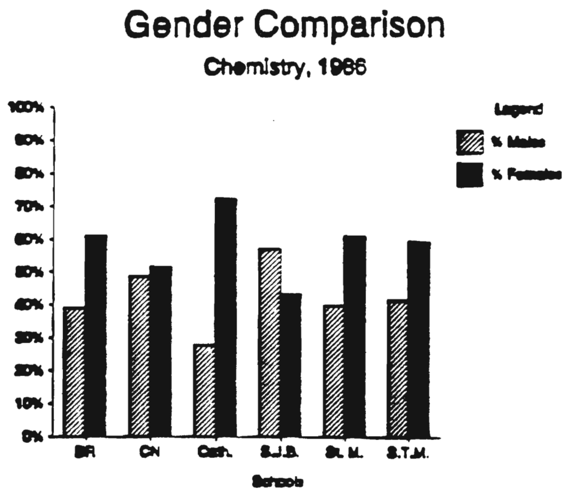
Graph 7

A Gender-based Summary of Enrolment in Biology 1988



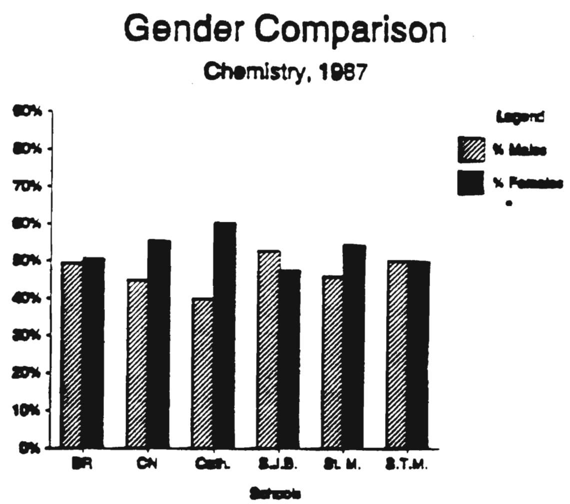
Graph 8

A Gender-based Summary of Enrolment in Chemistry 1986



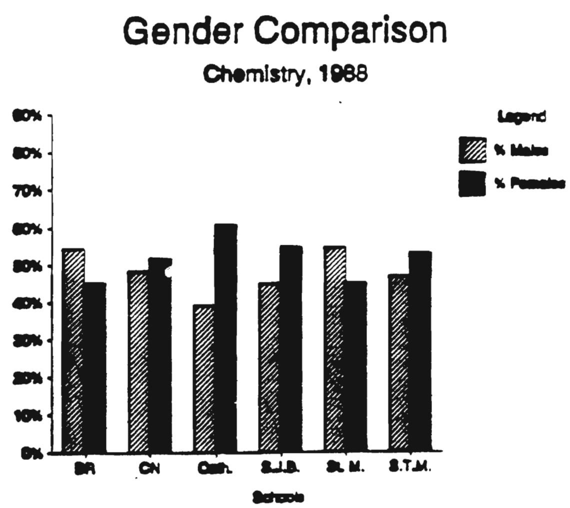
Graph 9

A Gender-based Summary of Enrolment in Chemistry 1987



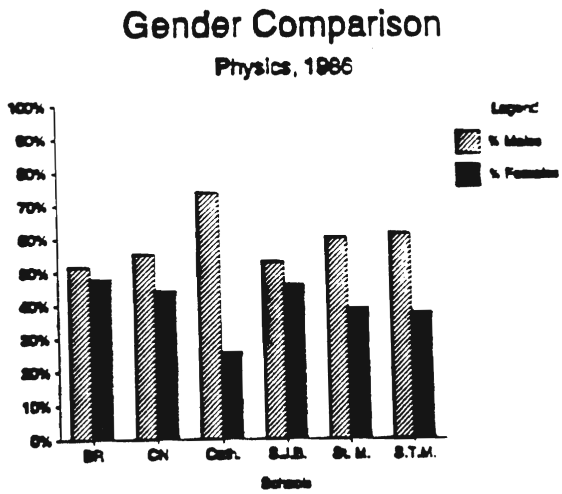
Graph 10

A Gender-based Summary of Enrolment in Chemistry 1988



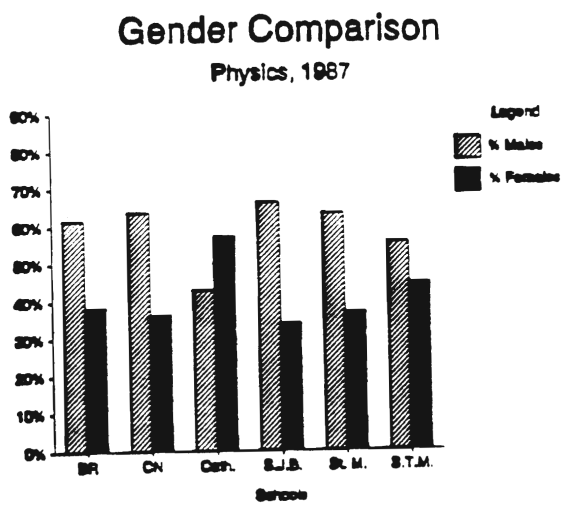
Graph 11

A Gender-based Summary of Enrolment in Physics 1986



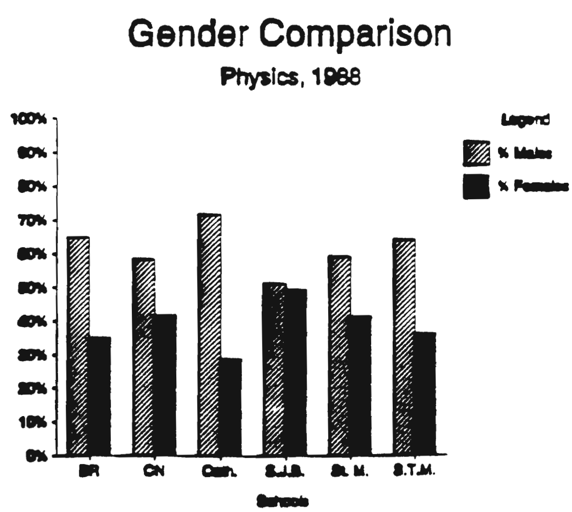
Graph 12

A Gender-based Summary of Enrolment in Physics 1987



Graph 13

A Gender-based Summary of Enrolment in Physics 1988



STM, 1986 and 1987, more females were enrolled in the course. In 1988, more females were enrolled at CN, Cath., SJB, and STM. This can be seen on Graphs 8, 9, and 10. Physics enrolment was completely male dominated from 1986 to 1988 with only the exception of Cathedral 1987, where there was a higher percentage of girls enrolled in Physics. This is depicted on Graphs 11, 12, and 13.

Thus, the trend of girls studying Biology and boys studying physics continues to hold firm, with Chemistry falling somewhere in the middle. These trends would have been better substantiated, had more data been available. While the information required was available in old files of September Reports at each of the schools, the time and manpower necessary to collect it from each school was well beyond that available to the researcher. It was also unavailable from the Ministry of Education even up to the moment of this writing; therefore, the data presented had to suffice.

ii) The Sample

As previously mentioned, the population (N) was expected to be close to 2,500. In fact, once all of the questionnaires were returned and the Scantron sheets counted, the population was 1,345. When analysis of the questionnaires was begun, those question responses which did not appear on the Scantron sheets; that is, the short answer questions, were tabulated by hand. The total for these questions was 1,297 respondents. The discrepancy of 3.57% occurred due to questions left unanswered, blank, or completed with very silly or derogatory remarks, which made a certain number of questionnaires essentially useless. Therefore, these were discarded making all of the analyses done by hand based on a population of 1,297, while the frequencies and chi-square analyses are based mainly on a value of 1,345.

A summary of the nature of the sample is presented in Table 3 . The male and female respondents are described by number and percentage of N, where N was 1,297. The table shows that more females than males participated in the study, 57.75% and 42.25% respectively. The breakdown of males and females for each school is also shown, along with the percentage of the total sample that is represented by each school. The largest participation came from SJB.

The sample is further described by a breakdown of science course enrolment, found in Table 4 . This table lists, for each school, five courses of science study - 1A1, 2A1, Biology, Chemistry, and Physics (for which all senior level courses were amalgamated). It presents a profile of the male and female respondents with respect to their enrolment in the science courses available to them at their schools. In_each case, the largest percent enrolment was observed for science

Table 3

<u>A Summary of the Survey Respondents</u>

School	Males	%	Females	%	Total	% of N
BR	112	43.92%	143	56.08%	255	19.66%
CN	89	43.20%	117	56.80%	206	15.88%
Cath	41	25.63%	119	74.38%	160	12.34%
SJB	145	45.89%	171	54.11%	316	24.36%
StM	73	40.11%	109	59.89%	182	14.03%
STM	88	49.44%	90	50.56%	178	13.72%
Totals	548	42.25%	749	57.75%	1297	100.00%

Table 4

A Summary of the Science Course Enrolment of the Sample

School	Subject	Males	%	Females	%
BR	1A1	40	15.69%	48	18.82%
(255)	2A1	17	6.67%	37	14.51%
	Bio	21	8.24%	35	13.73%
	Chem	12	4.71%	12	4.71%
	Phys	22	8.63%	11	4.31%
CN	1A1	28	13.59%	55	26.70%
(206)	2A1	20	9.71%	26	12.62%
	Bio	4	1.94%	5	2.43%
	Chem	15	7.28%	20	9.71%
	Phys	22	10.68%	11	5.34%
Cath	1A1	22	13.75%	43	26.88%
(160)	2A1	15	9.38%	23	14.38%
	Bio	0	0.00%	49	30.63%
	Chem	4	2.50%	4	2.50%
	Phys	0	0.00%	0	0.00%
SJB	1A1	22	6.96%	35	11.08%
(316)	2A1	54	17.09%	72	22.78%
	Bio	19	6.01%	25	7.91%
	Chem	24	7.59%	24	7.59%
	Phys	26	8.23%	15	4.75%
StM	1A1	17	9.34%	41	22.53%
(182)	2A1	19	10.44%	19	10.44%
	Bio	25	13.74%	34	18.68%
	Chem	9	4.95%	12	6.59%
	Phys	3	1.65%	3	1.65%
STM	1A1	18	10.11%	25	14.04%
(178)	2A1	38	21.35%	40	22.47%
	Bio	5	2.81%	11	6.18%
	Chem	6	3.37%	9	5.06%
	Phys	21	11.80%	5	2.81%

1A1 and 2A1, the intermediate level courses. This was true for both the male and female respondents. The males were enrolled in Physics and Chemistry over Biology, except for St.M, where more were enrolled in Biology and Chemistry. Females were enrolled in Biology and Chemistry with the exception of CN, where more females were taking Chemistry and Physics. This information represented those students taking advanced-level science courses in the second semester of the 1990-1991 school year. It may have been interesting to run the study in both semesters. This would have provided a larger sample and might have added further evidence to the patterns identified for the study sample. Once again, the logistics of doing this made it difficult to complete.

iii) <u>The Questionnaire</u>

The questionnaire used for the large sample consisted of 104 questions, which were answered on Scantron sheets, and 11 questions for which short answers were provided. For the sake of clarity and fluency, the following discussion will appear in the same order as the sections appeared in the questionnaire. In all cases, both frequency of response and significant chi-square values will be included. Where applicable, percentage of response based on gender will also be considered, especially for questions tabulated by hand.

a) <u>Demographics</u>.

Part A of the questionnaire dealt with the collection of basic demographic information. This discussion will present those questions deemed to be significant and the resultant responses.

The first question identified the schools:

A. Bishop Ryan

B. Cardinal Newman

C. Cathedral Boys' and Cathedral Girls'

D. St. Mary

E. St. Thomas More.

Since the Scantron sheet had only five response bubbles, the researcher's school, St. Jean de Brebeuf, was left off of the list and respondents from that school were asked not to complete Question One. Also, the Cathedrals were combined into one option. Analysis of frequency showed 16.2% (218) from BR, 14.6% (197) from CN, 12.3% (165) from the Cathedrals, 13.5% (182) from St.M., 13.3% (179) from STM, and 30.0% (404) from SJB. This resulted in a population of 1,345 with the gender breakdown of the sample being 38.6% (519) male and 54.6% (735) female. Also, 6.8% (91) of the responses were considered "missing" which means that the responses may have been illegible by the scanner or another choice was made besides (A) for male or (B) for female on the Scantron sheet.

Question Three provided age levels of the respondents. Frequencies indicated that 27.7% (373) were 14-15 years old, 26.6% (358) were 15-16 years old, 15.8% (212) were 16-17 years old, 13.2% (178) were 17-18 years old, and 10.0% (135) were 18-19 years old. The largest proportion of the population was in the 14-to-16 year old range. There were 6.6% (89) responses missing indicative of illegible responses, since the range of responses was A to E. The chi-square provided the gender breakdown for this question. For the ages 14-15 years, 29.3% (151) were male and 30.0% (219) were female. For the 15-16 year range, 26.8% (138) were male and 29.6% (216) were female. For the range of 16-17 years, 14.0% (72) were male, 19.0% (139) were female. For ages 17-18 years, 15.9% (82) were male and 12.7% (93) were female. Finally, for the 18-19 year range, 14.0% (72) were male and 8.6% (63) were female. The chi-square value was 15.58635 with a significance of 0.0036. The results may also have been affected by the timing of the study and hence those students taking science in Semester Two of the 1990-1991 school year.

The next question sought to identify the religion of the respondents. Since the survey was conducted in a separate school board, it was expected that the majority, if not all, of the respondents would be Roman Catholic. Two options of Roman Catholic (A) and other (B) were provided. Frequency of response indicated 89.3% (1201) were Roman Catholic, 4.2% (57)

responded "other." There were 6.4% (87) "missing" which will hereinafter mean that no response was scanned or available due to illegible responses, or wrongly placed responses, or no response provided at all. The chi-square analysis further substantiated the responses by indicating that 95.0% (492) of the males and 95.5% (699) of the females were Roman Catholic. For the non-Catholic response, 4.4% (23) males and 4.5% (33) females chose the response. Since becoming publicly funded, the separate board has allowed any student, regardless of faith, to enrol in its schools. This might explain the presence of some non-Catholics.

Question Five identified the number of children in the family. Five choices were offered ranging from one (1) to five (5) or more children. It was observed that the majority of the families of the responses had two or three children.

Along the same family theme, Question Six asked for the identification of the most important member of the family. The choices listed mother, father, sister, brother, and all members equally important. Frequencies were 16.1% (216) for mother, 6.7% (90) for father, 2.2% (30) for sister, 2.7% (36) for brother, and 64.5% (868) for all members equally important. The missing responses made up 7.8% (105). This seems to indicate the importance the respondents placed on all of the members of the family. The chi-square provided further data with a value of 21.18701 and a significance of 0.0003. Of those choosing mother as most important, 13.9% (70) were male and 19.6% (142) were female. For father as most important, males made up 10.3% (52) while females made up 5.3% (38) of the responses. Of those choosing sister as most important, 1.4% (7) were male and 3.2% (23) were female; and of those choosing brother, 3.4% (17) were male and 2.4% (17) were female. The response of interest, considering all family members of equal importance, was expressed by 71.1% (359) of the males and 69.6% (503) of the females. Obviously, the family as a whole is playing an important role for these respondents. If the figures are re-examined, there are more males to whom the father plays an important role and more females to whom the mother plays an important role. Thus, the importance of certain family members is a significant factor when the gender responses are considered.

Next, Question Seven provided for a breakdown of grade levels. Choices ranged from Grades Nine through OAC. Of the total sample

27.6% (371) were in Grade Nine

27.1% (365) were in Grade Ten

19/5% (262) were in Grade 11

10.0% (135) were in Grade 12

and 8.9% (120) were in OAC.

There were missing responses of 6.8% (92) for this question.

In terms of the chi-square, its value was 16.94682 with a significance of 0.0020, making grade another significant gender response. For the male respondents:

27.8% (142) were in Grade Nine
28.4% (145) were in Grade Ten
18.0% (92) were in Grade 11
12.9% (66) were in Grade 12
and 12.7% (65) were in OAC.

For the female respondents:

30.7% (225) were in Grade Nine
29.9% (219) were in Grade Ten
22.7% (166) were in Grade 11
9.3% (68) were in Grade 12
and 7.4% (54) were in OAC.

Again, it is proposed that the nature of the group at the time of administration of the questionnaire is being reflected by this analysis.

The sample consisted of students taking advanced level science at the time of the completion of the study. The expectation was that the majority of their courses were also at the advanced level. This was confirmed by Question Eight.

Students were asked if they had ever skipped a grade in Question Nine. The choices of response were yes or no.

Frequencies indicated that the majority had never skipped a grade so this would not seem to have any bearing on science enrolment.

Students' interest in teachers was measured to a small extent in Question Ten, which asked students to identify the sex of their favourite teacher. They had only two choices - male or female. In the frequency breakdown, 53.4% (718) chose male teachers as their favourite and 37.0% (497) chose female teachers. Missing responses comprised 9.6% (130) of the responses. This question proved to be another significant one in light of the gender responses. The chi-square value was 77.62437 with a significance of 0.00001 indicative of a definite difference in male/female response. Male teachers were favoured by 73.8% (366) of the male respondents and by 48.6% (346) of the female respondents. Female teachers were favoured by 25.8% (128) of the male respondents and by 51.1% (364) of the female respondents. It seems apparent that teachers serve as a strong influence to students. It was not asked, however if their favourite science teacher were male or female, which would have been even more significant and applicable to this study. Regardless, the fact that male teachers were preferred by male students and female teachers were preferred by female students offers the suggestion of role models. More will be discussed about this when qualities of favourite teachers are considered.

With respect to science study, respondents were asked to specify those disciplines of science which they preferred in Question 11. Combinations were offered in order to verify earlier enrolment patterns which suggested that males preferred Physics and Chemistry and that females preferred Biology and Chemistry. Three pairs were offered - Biology and Chemistry, Chemistry and Physics, Physics and Biology - and the option to choose all three disciplines. Frequency of response revealed that 35.8% (482) preferred Biology and Chemistry, 21.6% (290) preferred Chemistry and Physics, 14.0% (200) preferred Physics and Biology, and 19.4% (261) preferred them all. Missing responses made up 8.3% (112). the chi-square value was 83.12822 with a significance of 0.00001, making this another significant gender question. For the males, 26.7% (136) preferred Biology and Chemistry, 34.2% (174) preferred Chemistry and Physics, 17.3% (88) preferred Physics and Biology and 20.6% (105) preferred all three disciplines. For the females, 47.5% (342) preferred Biology and Chemistry, 15.7% (113) preferred Chemistry and Physics, 15.4% (111) preferred Physics and Biology, and 21.3% (153) preferred all three disciplines. Interestingly, these figures would appear to support the enrolment patterns for science for 1986 - 1988 (see Table 2).

Still on the topic of science interest, students were asked about their intentions with respect to the number of science courses in which they were going to enrol over their high school education. Question 12 addressed this topic. Options provided ranged from two (the minimum requirement) to more than four. The chi-square value of 8.24049 with significance 0.0832, highlights that both the males and the females intended on taking more than four courses, 39.1% (201) and 40.6% (297) respectively. The females appeared to have somewhat greater aspirations to this when compared to the males but, overall, intention to study science does not seem to be a significant factor.

The issue of receiving help with science was addressed in Questions 13 and 14. The figures did not show a significant gender response indicating that help did not contribute to science enrolment.

Educational aspiration was measured in Question 15. Students were asked to predict how far they would like to go in school. Responses ranged from completion of high school only to professional or doctorate studies. Very few respondents aspired to the completion of high school only, 0.8% (11). To complete their education at the community college level was chosen by 11.4% (155). A university education was chosen by 45.0% (605), graduate school by 8.7% (117), and professional/doctorate studies by 26.8% (361).

There were 7.1% (96) missing responses. The choices of the male respondents were 1.0% (5) for completion of high school only, 14.6% (75) for community college, 48.4% (249) for university, 7.4% (38) for graduate school, and 26.8% (361) for professional/doctorate studies. The results were similar for the females - 0.7% (5) for high school, 10.9% (79) for community college, 48.3% (349) for university, 10.9% (79) for graduate school, and 29.2% (211) for professional/doctorate studies. The respondents clearly have very high educational aspirations, which may indicate the belief that a better education will lead to a better career.

Career aspirations logically followed in Question 16. Examination of the response frequencies showed the highest proportion to be for other professional, 76.1% (1023). The remaining categories were chosen based on 0.9% (12) unskilled worker, 4.8% (64) skilled worker, 3.6% (49) sales/clerical, 7.4% (100) white collar/managerial. Missing responses made up 7.2% (97). The chi-square value was 51.10219 and the significance was 0.00001. Both males and females showed very high career aspirations. Males chose the other professional category at a rate of 76.7% (391) and females chose it at a rate of 85.8% (623). This is interesting to note on the part of the females since many also revealed strong aspirations towards marriage and family, which will be discussed shortly. For the remaining occupational categories, males aspired to unskilled work at 1.8% (9), skilled work at 9.0% (46), sales/clerical work at 2.2% (11), and white collar/managerial work at 10.4% (53). Females aspired to unskilled work at 0.3% (2), skilled work at 2.2% (16), sales/clerical work at 5.2% (38), and white collar/managerial work at 6.5% (47). In summary, it would appear that many of the students who would like to study science throughout high school, also aspire to a long education beyond high school, and a professional occupation afterwards. To nurture this further, the schools should provide ample opportunity for successful science study for the development of strong study and thinking skills and consistent work habits.

Questions 17 through 20 bear the theme of marital and familial aspirations. Students were asked at what age they would like to marry in Question 17. Options ranged from 18-20 to over 35 years of age. Frequencies showed 1.7% (23) wishing to marry between the ages 18 and 20 years, 49.0% (659) between the ages of 21 to 25 years, 37.2% (500) between the ages of 26 to 30 years, 3.3% (44) between the ages of 31 to 35 years, and 1.3% (17) wishing to be over 35 years of age. This factor proved to be significant to gender, having a chi-square of 25.73977 and significance of 0.00001. The preferred age ranges for the males were:

2.4% (12) for 18-20 years

45.1% (230) for 21-25 years

45.5% (232) for 26-30 years

5.1% (26) for 31-35 years

and 2.0% (10) for over 35 years.

The preferred age ranges for the females were:

1.4% (10) for 18-20 years

58.7% (423) for 21-25 years

36.5% (263) for 26-30 years

2.5% (18) for 31-35 years

and 1.0% (7) for over 35 years.

Thus, both males and females hope to marry in their twenties, with more females aspiring toward the early twenties and the males evenly divided between the early and late twenties. In this respect, Question 18 highlights the respondents' feelings about the importance of marriage. The range of responses was from extremely important to not important at all. The frequencies were 16.7% (225) for extremely important, 23.9% (322) for very important, 37.0% (497) for important, 12.3% (166) for not very important, and 3.1% (42) for not important at all. The missing responses comprised 6.9% (93) of the frequencies. The chi-square was 27.09093 with a significance of 0.00001. The males expressed that marriage was extremely important at 21.9% (112), very important at 29.7% (152), important at 36.7% (188), not very important at 9.4% (48) and not important at all at 2.3% (12). The female response was 15.4% (112) for extremely important, 22.9% (167) for very important, 41.6% (303) for important, 16.2% (118) for not very important, and 4.0% (29) for not important at all. This significant difference shows that the males and females believe marriage to be important to their lives. When the totals for the first three categories are considered, marriage was more important to the males (88.3%) than the females (79.9%). It may be possible that the females are considering their careers to be as important as marriage, recalling the occupational aspirations which showed females aspiring to be professionals.

Along the same lines, is the question regarding having children, that is, Question 19. Only yes and no were offered as response choices. Overall, 95.4% (1148) chose the positive response, 7.1% (95) chose the negative response, and 7.7% (102) responses were missing. Both the males and the females indicated very high response toward definitely having children.

The number of children desired was posed in Question 20. The choices ranged from one (1) to four (4) or more children. Having a family did not prove to be a significant motivating factor, with both groups opting for a two-child family.

At this point, the demographics that could be answered on the Scantron sheets ends. There were seven sections for which the respondents were requested to provide short answers. The questions dealt with ethnic background, parents' occupations, favourite subject, favourite teacher, qualities of favourite teacher, and science courses in which the students were enrolled at the time of the administration of the questionnaire. These questions were not analyzed by computer, but rather, simply tallied and expressed as percentages of N, where N was 1297. The discussion will follow the same order as did the appearance of the questions in the questionnaire.

The ethnic background of the students was collected simply to try to obtain a profile of the population being studied. Table 5 shows, for each school, the number of males and the number of females of each origin. Where no numbers appear, there were no students of that particular origin at that school. Each school had its own particular ethnic make-up. Bishop Ryan showed its largest ethnic origins to be Italian and Croation. Cardinal Newman's largest ethnic groups were also Italian and Croation. At the Cathedrals the largest groups were Italian, Canadian, and Phillippino. At St. Mary's, the largest ethnicities were Italian (to a lesser degree than the other schools), Canadian, Irish, British, and Polish. At

Table 5

A School-by-School Listing of Ethnicities by Respondents

	Ethnic Origin	# of Students Males	Females	% of N Males N = 255	Females
Bishop Ryan	African				
	American				
	Arabian	1		0.39%	
	Argentinian			0.00%	
	Armenian			0.00%	
	Asian			0.00%	
	Assyrian			0.00%	
	Austrian		1	0.00%	0.39%
	British	9	6	3.53%	2.35%
	Canadian	7	15	2.75%	5.88%
	Chilean			0.00%	0.00%
	Chinese			0.00%	0.00%
	Columbian		1	0.00%	0.39%
	Croatian	13	16	5.10%	6.27%
	Cuban			0.00%	0.00%
	Czechoslovakian		1	0.00%	0.39%
	Dutch		2	0.00%	0.78%
	French	4	8	1.57%	3.14%
	German		2	0.00%	0.78%
	Greek			0.00%	0.00%
	Guyanian			0.00%	0.00%
	Hungarian		2	0.00%	0.78%
	Indian (East)			0.00%	0.00%
	Indian (N. A.)			0.00%	0.00%
	Indian (West)	3	1	1.18%	0.39%
	Indonesian			0.00%	0.00%
	Iranian	1		0.39%	0.00%
	Irish	2	3	0.78%	1.18%
	Italian	49	44	19.22%	17.25%
	Jamaican			0.00%	0.00%
	Korean		1	0.00%	0.39%
	Latvian			0.00%	0.00%
	Lebanese			0.00%	0.00%
	Lithuanian	1		0.39%	0.00%
	Maltese		1	0.00%	0.39%
	Mexican			0.00%	0.00%
	Nicaraguan	1		0.39%	0.00%
	Philippino		1	0.00%	0.39%
	Polish	5	12	1.96%	4.71%
	Portugese	2	3	0.78%	1.18%
	Russian	1		0.39%	0.00%
	Scottish	3	3	1.18%	1.18%
	Slovenian	1		0.39%	0.00%
	Spanish		3	0.00%	1.18%
	Sri Lankan			0.00%	0.00%
	Swedish			0.00%	0.00%
	Thai			0.00%	0.00%
	Ukranian	3	10	1.18%	3.92%
	Vietnamese		1	0.00%	0.39%
	Yugoslavian	2	1	0.78%	0.39%
	No Response	4	5	1.57%	1.96%

Table 5 continues

A School-by-School Listing of Ethnicities by Respondents

Cardinal				N = 206	
Newman	African	1		0.49%	
	American			0.00%	
	Arabian			0.00%	
	Argentinian			0.00%	
	Armenian			0.00%	
	Asian			0.00%	
	Assyrian			0.00%	
	Austrian			0.00%	
	British	1	3	0.49%	1.46%
	Canadian	6	8	2.91%	3.88%
	Chilean			0.00%	0.00%
	Chinese	1	1	0.49%	0.49%
	Columbian			0.00%	0.00%
	Croatian	18	27	8.74%	13.11%
	Cuban			0.00%	0.00%
	Czechoslovakian	1		0.49%	0.00%
	Dutch			0.00%	0.00%
	French		4	0.00%	1.94%
	German			0.00%	0.00%
	Greek			0.00%	0.00%
	Guyanian	1		0.49%	0.00%
	Hungarian			0.00%	0.00%
	Indian (East)	1		0.49%	0.00%
	Indian (N. A.)		1	0.00%	0.49%
	Indian (West)			0.00%	0.00%
	Indonesian			0.00%	0.00%
	Iranian			0.00%	0.00%
	Irish	1	5	0.49%	2.43%
	Italian	39	49	18.93%	23.79%
	Jamaican			0.00%	0.00%
	Korean			0.00%	0.00%
	Latvian			0.00%	0.00%
	Lebanese			0.00%	0.00%
	Lithuanian			0.00%	0.00%
	Maltese			0.00%	0.00%
	Mexican			0.00%	0.00%
	Nicaraguan			0.00%	0.00%
	Philippino	1		0.49%	0.00%
	Polish	8	8	3.88%	3.88%
	Portugese	2	2	0.97%	0.97%
	Russian			0.00%	0.00%
	Scottish	1		0.49%	0.00%
	Slovenian	1		0.49%	0.00%
	Spanish	1		0.49%	0.00%
	Sri Lankan			0.00%	0.00%
	Swedish			0.00%	0.00%
	Thai			0.00%	0.00%
	Ukranian	3	1	1.46%	0.49%
	Vietnamese			0.00%	0.00%
	Yugoslavian	1	3	0.49%	1.46%
	No Response	1	4	0.49%	1.94%

Table 5 continues

Table 5

A School-by-School Listing of Ethnicities of Respondents

				N = 160	
Cathedral Schools	American				0.00%
	Arabian	1		0.63%	0.00%
	Argentinian			0.00%	0.00%
	Armenian			0.00%	0.00%
	Asian			0.00%	0.00%
	Assyrian			0.00%	0.00%
	Austrian			0.00%	0.00%
	British	1	2	0.63%	1.25%
	Canadian	5	7	3.13%	4.38%
	Chilean			0.00%	0.00%
	Chinese		1	0.00%	0.63%
	German	1	1	0.63%	0.63%
	Greek			0.00%	0.00%
	Guyanian			0.00%	0.00%
	Hungarian	1	1	0.63%	0.63%
	Indian (East)		2	0.00%	1.25%
	Indian (N. A.)		1	0.00%	0.63%
	Indian (West)		1	0.00%	0.63%
	Indonesian			0.00%	0.00%
	Iranian			0.00%	0.00%
	Irish	2	6	1.25%	3.75%
	Italian	7	32	4.38%	20.00%
	Jamaican	1	1	0.63%	0.63%
	Korean			0.00%	0.00%
	Latvian			0.00%	0.00%
	Lebanese			0.00%	0.00%
	Lithuanian			0.00%	0.00%
	Maltese			0.00%	0.00%
	Mexican		1	0.00%	0.63%
	Nicaraguan			0.00%	0.00%
	Philippino		2	0.00%	1.25%
	Polish	9	10	5.63%	6.25%
	Portugese	8	28	5.00%	17.50%
	Russian			0.00%	0.00%
	Scottish		4	0.00%	2.50%
	Slovenian			0.00%	0.00%
	Spanish	2	4	1.25%	2.50%
	Sri Lankan		1	0.00%	0.63%
	Swedish			0.00%	0.00%
	Thai		1	0.00%	0.63%
	Ukranian		1	0.00%	0.63%
	Vietnamese		1	0.00%	0.63%
	Yugoslavian		2	0.00%	1.25%
	No Response	1		0.63%	0.00%

Table 5 continues

Table 5

A School-by-School Listing of Ethnicities of Respondents

St. Jean de Brebeuf				N = 317	
	African	1		0.32%	
	American	1		0.32%	
	Arabian	1		0.32%	
	Argentinian			0.00%	
	Armenian			0.00%	
	Asian	1		0.32%	
	Assyrian		2	0.00%	0.63%
	Austrian			0.00%	0.00%
	British	6	12	1.89%	3.79%
	Canadian	15	21	4.73%	6.62%
	Chilean	1		0.32%	0.00%
	Chinese	1		0.32%	0.00%
	Columbian			0.00%	0.00%
	Croatian	6	6	1.89%	1.89%
	Cuban			0.00%	0.00%
	Czechoslovakian	1		0.32%	0.00%
	Dutch	2	2	0.63%	0.63%
	French	8	2	2.52%	0.63%
	German	3	5	0.95%	1.58%
	Greek			0.00%	0.00%
	Guyanian			0.00%	0.00%
	Hungarian	7	6	2.21%	1.89%
	Indian (East)			0.00%	0.00%
	Indian (N. A.)	2	2	0.63%	0.63%
	Indian (West)	3	4	0.95%	1.26%
	Indonesian			0.00%	0.00%
	Iranian			0.00%	0.00%
	Irish	11	7	3.47%	2.21%
	Italian	45	47	14.20%	14.83%
	Jamaican			0.00%	0.00%
	Korean			0.00%	0.00%
	Latvian			0.00%	0.00%
	Lebanese	1		0.32%	0.00%
	Lithuanian			0.00%	0.00%
	Maltese			0.00%	0.00%
	Mexican	1		0.32%	0.00%
	Nicaraguan			0.00%	0.00%
	Philippino	7	18	2.21%	5.68%
	Polish	7	9	2.21%	2.84%
	Portugese	6	7	1.89%	2.21%
	Russian			0.00%	0.00%
	Scottish	3	9	0.95%	2.84%
	Slovenian			0.00%	0.00%
	Spanish	2	3	0.63%	0.95%
	Sri Lankan			0.00%	0.00%
	Swedish	1	1	0.32%	0.32%
	Thai			0.00%	0.00%
	Ukranian	2	4	0.63%	1.26%
	Vietnamese			0.00%	0.00%
	Yugoslavian		3	0.00%	0.95%
	No Response	1	1	0.32%	0.32%

Table 5 continues

Table 5

A School-by-School Listing of Ethnicities of Respondents

St. Mary's				N = 182	
	African	1		0.55%	
	American			0.00%	
	Arabian			0.00%	
	Argentinian			0.00%	
	Armenian		1	0.00%	0.55%
	Asian			0.00%	0.00%
	Assyrian			0.00%	0.00%
	Austrian			0.00%	0.00%
	British	8	9	4.40%	4.95%
	Canadian	7	21	3.85%	11.54%
	Chilean			0.00%	0.00%
	Chinese	2	1	1.10%	0.55%
	Columbian			0.00%	0.00%
	Croatian	2	2	1.10%	1.10%
	Cuban			0.00%	0.00%
	Czechoslovakian		1	0.00%	0.55%
	Dutch		5	0.00%	2.75%
	French		2	0.00%	1.10%
	German	5	6	2.75%	3.30%
	Greek		1	0.00%	0.55%
	Guyanian			0.00%	0.00%
	Hungarian	6	2	3.30%	1.10%
	Indian (East)	2	2	1.10%	1.10%
	Indian (N. A.)			0.00%	0.00%
	Indian (West)			0.00%	0.00%
	Indonesian	1		0.55%	0.00%
	Iranian			0.00%	0.00%
	Irish	8	15	4.40%	8.24%
	Italian	12	15	6.59%	8.24%
	Jamaican	2	2	1.10%	1.10%
	Korean			0.00%	0.00%
	Latvian	1		0.55%	0.00%
	Lebanese			0.00%	0.00%
	Lithuanian	2		1.10%	0.00%
	Maltese			0.00%	0.00%
	Mexican	1		0.55%	0.00%
	Nicaraguan			0.00%	0.00%
	Philippino	1	1	0.55%	0.55%
	Polish	4	9	2.20%	4.95%
	Portugese	2	2	1.10%	1.10%
	Russian		1	0.00%	0.55%
	Scottish	1	6	0.55%	3.30%
	Slovenian			0.00%	0.00%
	Spanish	1		0.55%	0.00%
	Sri Lankan			0.00%	0.00%
	Swedish			0.00%	0.00%
	Thai			0.00%	0.00%
	Ukranian		1	0.00%	0.55%
	Vietnamese			0.00%	0.00%
	Yugoslavian			0.00%	0.00%
	No Response	4	4	2.20%	2.20%

Table 5 continues

Table 5

A School-by-School Listing of Ethnicities of Respondents

St. Thomas More N = 178

African				
American				
Arabian	1		0.56%	
Argentinian		1	0.00%	0.56%
Armenian			0.00%	0.00%
Asian			0.00%	0.00%
Assyrian			0.00%	0.00%
Austrian			0.00%	0.00%
British	3	3	1.69%	1.69%
Canadian	9	3	5.06%	1.69%
Chilean			0.00%	0.00%
Chinese		3	0.00%	1.69%
Columbian			0.00%	0.00%
Croatian	2		1.12%	0.00%
Cuban			0.00%	0.00%
Czechoslovakian	1		0.56%	0.00%
Dutch	2	2	1.12%	1.12%
French		4	0.00%	2.25%
German	1	2	0.56%	1.12%
Greek			0.00%	0.00%
Guyanian			0.00%	0.00%
Hungarian	1	1	0.56%	0.56%
Indian (East)	1	2	0.56%	1.12%
Indian (N. A.)			0.00%	0.00%
Indian (West)		2	0.00%	1.12%
Indonesian			0.00%	0.00%
Iranian			0.00%	0.00%
Irish	5	10	2.81%	5.62%
Italian	29	35	16.29%	19.66%
Jamaican			0.00%	0.00%
Korean			0.00%	0.00%
Latvian			0.00%	0.00%
Lebanese	2	1	1.12%	0.56%
Lithuanian	1		0.56%	0.00%
Maltese	1		0.56%	0.00%
Mexican			0.00%	0.00%
Nicaraguan			0.00%	0.00%
Philippino	9	3	5.06%	1.69%
Polish	1	2	0.56%	1.12%
Portugese	4	4	2.25%	2.25%
Russian			0.00%	0.00%
Scottish	6	2	3.37%	1.12%
Slovenian			0.00%	0.00%
Spanish	3	1	1.69%	0.56%
Sri Lankan			0.00%	0.00%
Swedish			0.00%	0.00%
Thai			0.00%	0.00%
Ukranian		4	0.00%	2.25%
Vietnamese			0.00%	0.00%
Yugoslavian		1	0.00%	0.56%
No Response	6	5	3.37%	2.81%

St. Thomas More, the major groups were Italian, Irish, Phillippino, and Canadian. In order to obtain a better spectrum of the ethnicities across the large sample, Table 6 was created, which summarizes the data from the individual schools . The table shows 50 possible ethnic origins. The percentages of the ten prevalent ethnic origins of the males were:

Italian	13.96%
Canadian	3.78%
Croation	3.16%
Polish	2.62%
Irish	2.24%
British	2.16%
Portugese	1.85%
Phillippino	1.39%
Hungarian	1.16%
Scottish	1.08%.

The ten prevalent ethnic origins of the females were very similar, with two exceptions towards the groups found lower in the list:

Italian	17.12%
Canadian	5.78%

Croation	4.16%
Polish	3.86%
Irish	3.55%
Portugese	3.55%
British	2.70%
Phillippino	1.93%
Scottish	1.85%
French	1.62%.

This shows that the population was fairly evenly represented by the ethnic groups listed. It was interesting to learn the extent to which the Italians were represented. It was by far the highest group attending the Catholic schools being studied. Some suggestions can be offered for this. First, the Italians have always had a very strong commitment to the Church, so it is logical that this be extended to their children through obtaining an education at a Catholic school. Similarly, it might be assumed that the schools would carry on the same expectations, values, and morals that are demonstrated in the home. There was a higher percentage of females representative of this group, which might also be intentional on the part of the parents. Their belief may be that their daughters will be safer and better educated at Catholic schools. This discussion is not to say that the other ethnic groups do not hold the same feelings; most likely, they

Table 6

A Summary of Ethnicities of Respondents - Combined Schools

	Ethnic Origin	# of Students Males	Females	% of N Males	Females
Combined Schools				N = 1297	
	African	3	2	0.23%	0.15%
	American	1	0	0.08%	0.00%
	Arabian	4	0	0.31%	0.00%
	Argentinian	0	1	0.00%	0.08%
	Armenian	0	1	0.00%	0.08%
	Asian	1	0	0.08%	0.00%
	Assyrian	0	2	0.00%	0.15%
	Austrian	0	1	0.00%	0.08%
	British	28	35	2.16%	2.70%
	Canadian	49	75	3.78%	5.78%
	Chilean	1	0	0.08%	0.00%
	Chinese	4	6	0.31%	0.46%
	Columbian	1	2	0.08%	0.15%
	Croatian	41	54	3.16%	4.16%
	Cuban	0	1	0.00%	0.08%
	Czechoslovakian	3	2	0.23%	0.15%
	Dutch	5	11	0.39%	0.85%
	French	12	21	0.93%	1.62%
	German	10	16	0.77%	1.23%
	Greek	0	1	0.00%	0.08%
	Guyanian	1	0	0.08%	0.00%
	Hungarian	15	12	1.16%	0.93%
	Indian (East)	4	6	0.31%	0.46%
	Indian (N. A.)	2	4	0.15%	0.31%
	Indian (West)	6	8	0.46%	0.62%
	Indonesian	1	0	0.08%	0.00%
	Iranian	1	0	0.08%	0.00%
	Irish	29	46	2.24%	3.55%
	Italian	181	222	13.96%	17.12%
	Jamaican	3	3	0.23%	0.23%
	Korean	0	1	0.00%	0.08%
	Latvian	1	0	0.08%	0.00%
	Lebanese	3	1	0.23%	0.08%
	Lithuanian	4	0	0.31%	0.00%
	Maltese	1	1	0.08%	0.08%
	Mexican	2	1	0.15%	0.08%
	Nicaraguan	1	0	0.08%	0.00%
	Philippino	18	25	1.39%	1.93%
	Polish	34	50	2.62%	3.86%
	Portugese	24	46	1.85%	3.55%
	Russian	1	1	0.08%	0.08%
	Scottish	14	24	1.08%	1.85%
	Slovenian	2	0	0.15%	0.00%
	Spanish	9	11	0.69%	0.85%
	Sri Lankan	0	1	0.00%	0.08%
	Swedish	1	1	0.08%	0.08%
	Thai	0	1	0.00%	0.08%
	Ukranian	8	21	0.62%	1.62%
	Vietnamese	0	2	0.00%	0.15%
	Yugoslavian	3	10	0.23%	0.77%
	No Response	17	20	1.31%	1.54%

do too. The focus on the Italians was made due to its large representation in the sample.

The next two questions sought to determine the occupations of parents. Again, the basic list of occupational categories, with examples, was provided. Table 7 provides a simple list of some of the occupations, as suggested by the respondents, and the category into which they were placed. These were occupations other than those suggested to the respondents in Question 16. A summary of the findings is found in Table 8, in which the occupations of the mothers and the fathers are presented separately. For the male respondents, the majority of the fathers' occupations fell into the "unskilled worker" category, 15.42% (200). Hamilton being a predominantly steel-making area, this result is not surprising. The same held true for the fathers of the female respondents, 23.59% (306). The next two prevalent categories were those of skilled worker and other professional. The occupations of the mothers of the respondents followed a similar pattern, with the highest category, unskilled worker, at 13.26% (172) for the male respondents and 19.28% (250) for the female respondents. The next two categories of prevalence were other professional and sales/clerical, slightly different from those identified for the fathers, possibly reflecting occupations that also permitted raising a family, or allowed part-time work.

Table 7

A Classification of Identified Occupations of Parents

SKILLED WORKER	OTHER PROFESSIONAL
baker	accountant
butcher	administrative coordinator
educational assistant	army officer
hairdresser	computer data processor
glass/bottle maker	doctor
lab technician	engineer
mailman	firefighter
security guard	interior designer
shoemaker	jeweller
tailor	lawyer
	marketing director
	meteorologist
	nurse
	pharmacist
	police officer
	principal
	psychiatrist
	physiotherapist
	social worker
	system analyst
	teacher-librarian
	x-ray & ultrasonographer
SALES/CLERICAL	**WHITE COLLAR/ MANAGERIAL**
bank teller	inspector
travel consultant	estimator

Table 8

Occupations of Mothers and Fathers of Respondents

Occupation	Fathers of Male Respondents	% of N (N=1297)	Fathers of Female Respondents	% of N (N=1297)
Unskilled worker	200	15.42	306	23.59
Skilled worker	117	9.02	113	8.71
Sales/Clerical	34	2.62	41	3.16
White collar/ Managerial	76	5.86	113	8.71
Other Professional	108	8.33	164	12.64
Unknown	48	3.71	58	4.47

	Mothers of Male Respondents	% of N (N=1297)	Fathers of Female Respondents	% of N (N=1297)
Unskilled worker	172	13.26	250	19.28
Skilled worker	50	3.86	75	5.78
Sales/Clerical	105	8.09	159	12.26
White collar/ Managerial	30	2.31	53	4.09
Other Professional	157	12.09	178	13.72
Unknown	35	2.71	35	2.71

These findings allow for a brief discussion of the role of the parents with respect to the future aspirations of their children. The respondents indicated very high academic intentions and hoped to achieve professional career status. If one is to consider the fact that there were numerous ethnicities often identified with the immigrant nature of the population of the area, it would seem feasible to suggest that many of the parents could not attain the same academic or career goals that they may have desired. Bearing this in mind, they worked hard to make the achievements they could in those lines of work that were available to them. In the geographic area being studied, industries play a very important part of the local economy and, hence, to the employment picture. The nature of the occupations of the group of parents in question would support this. Most likely, these parents would emphasize the importance and need for a good education as a stepping stone leading to an occupation that could be easier, cleaner, and financially more rewarding than that of the parents. Similarly, those parents who have professional careers would extend the same message. All of the parents serve as role models for their children and would encourage and support the future aspirations of their children.

The one section of Table 8 that should be explained is that called "unknown." There were some surveys in which no response was provided to the questions about parental occupations, so the need for the category was identified. However, in some cases, parents were retired from their occupations, or were deceased, or their occupation was just not known to the respondent for any number of reasons (separation, divorce, etc.). Therefore, the category includes all of these possibilities.

The next two short-answer questions dealt with the identification of favourite subject and favourite teacher. The findings have been combined and presented in Table 9 for the male respondents and Table 10 for the female respondents. These questions also relate back to Question 10, discussed earlier, regarding the sex of the favourite teacher. Males preferred male teachers to a greater extent than female teachers. Females showed a slightly higher preference for female teachers over male teachers. The top three favourite subjects of the males proved to be Math 7.94% (103), Science 7.56% (98), and Physical Education 5.17% (67). The favourite teachers of male respondents proved to be those who taught Science 5.94% (77), Math 5.71% (74), and Geography 4.78% (62). Teachers of English and Physical Education followed. The top three favourite subjects of the female respondents were Math 14.26% (185), Science 11.80% (153), and English 7.63% (99). Their favourite teachers taught Science, 13.80% (179), Math, 9.95% (129), and English, 9.485% (123). Teachers of Physical Education and History followed.

Table 9

Identified Subject and Teacher Preference of Male Respondents

	Subject	% of N (1297)	Teacher	% of N (1297)
Accounting	1	0.08%	0	0.00%
Art	28	2.16%	5	0.39%
Auto Mechanics	10	0.77%	8	0.62%
Business	13	1.00%	7	0.54%
Communication Tech.	3	0.23%	2	0.15%
Computer Studies	23	1.77%	13	1.00%
Consumer Studies	0	0.00%	0	0.00%
Drafting	22	1.70%	7	0.54%
Drama	7	0.54%	4	0.31%
Economics	0	0.00%	1	0.08%
English	22	1.70%	45	3.47%
ESL	0	0.00%	0	0.00%
Family Studies	1	0.08%	0	0.00%
French	3	0.23%	10	0.77%
Geography	20	1.54%	62	4.78%
History	15	1.16%	28	2.16%
Industrial Arts	6	0.46%	6	0.46%
Italian	0	0.00%	0	0.00%
Keyboarding	0	0.00%	1	0.08%
Law	3	0.23%	1	0.08%
Man In Society	0	0.00%	0	0.00%
Math	103	7.94%	74	5.71%
Music	11	0.85%	9	0.69%
Phys. Ed.	67	5.17%	41	3.16%
Religion	2	0.15%	19	1.46%
Science	98	7.56%	77	5.94%
Other	0	0.00%	2	0.15%
None	27	2.08%	35	2.70%

Table 10

Identified Subject and Teacher Preference of Females

	Subject	% of N (1297)	Teacher	% of N (1297)
Art	39	3.01%	7	0.54%
Auto Mechanics	1	0.08%	0	0.00%
Business	14	1.08%	4	0.31%
Communication Tech.	0	0.00%	0	0.00%
Computer Studies	9	0.69%	17	1.31%
Consumer Studies	1	0.08%	0	0.00%
Drafting	3	0.23%	3	0.23%
Drama	21	1.62%	8	0.62%
Economics	0	0.00%	1	0.08%
English	99	7.63%	123	9.48%
ESL	0	0.00%	2	0.15%
Family Studies	1	0.08%	3	0.23%
French	46	3.55%	33	2.54%
Geography	24	1.85%	38	2.93%
History	31	2.39%	42	3.24%
Industrial Arts	0	0.00%	0	0.00%
Italian	2	0.15%	0	0.00%
Keyboarding	5	0.39%	6	0.46%
Law	1	0.08%	2	0.15%
Man In Society	1	0.08%	6	0.46%
Math	185	14.26%	129	9.95%
Music	24	1.85%	15	1.16%
Phys. Ed.	56	4.32%	46	3.55%
Religion	2	0.15%	38	2.93%
Science	153	11.80%	179	13.80%
Other	0	0.00%	5	0.39%
None	31	2.39%	37	2.85%

This provides an interesting perspective. The top favourite subjects and teachers for both male and female respondents were Science and Math. Several reasons could be offered for this. The students may have based their responses on only the teachers of the courses in which they were enrolled at the time of the administration of the questionnaire. The item did not specify a particular time frame. The students may have experienced success under these teachers, making them stand out in their minds. Certainly favourite teachers and their qualities tend to remain in the minds of the students they taught. It is also possible that if the student really preferred the subject, logically he/she might also favour the teacher of that subject. The opposite situation is also feasible.

In order to determine reasons for their choices, the respondents were also asked why they chose the individual and to give reasons for their choices. The outcome of this question is summarized in Table 11, which lists ten characteristics which were identified by the respondents. They have been ranked from highest to lowest (1 to 10) and the percentage response has also been shown. The students were very candid with their comments, which were categorized in order to identify the ten characteristics. The students identified teaching abilities and/or techniques most often as the characteristic of their favourite teacher. Communication

Table 11

Characteristics of Favourite Teachers

Characteristic	% of N
1. Teaching ability/technique	20.25
2. Sense of humour	16.22
3. Friendly/easy to talk to	10.41
4. Makes class interesting	9.68
5. Can relate to students	8.53
6. Helpful/caring	8.27
7. Motivator	7.80
8. Intelligent/knowledgeable	7.59
9. Patient/understanding	6.75
10. Fairness	4.50
	100.00

(Rank ordered 1 = highest, 10 = lowest)

skills were next in importance. At the bottom of the list was fairness. It might have been expected that this one would have ranked higher, in light of the fact that students are very aware of their rights, but it did not. Overall, it appears that the students respond best to teachers who are communicative, friendly, and outgoing. The approachability of teachers and the willingness to form positive relationships with students was often cited as being important to the respondents. Since, for this study, science and math teachers were preferred, it is expected that those teachers must possess at least some of the characteristics mentioned. The teacher is often very influential to course enrolment and due to the fact that science teachers came out on top of the list of favourite teachers and science was one of the top preferred subjects, the influence of the teacher must be considered to be one of great significance.

The last question that was asked in this section dealt with listing the science courses that students were enrolled in at the time of the administration of the questionnaire. It was used to separate the respondents into intermediate and senior level groups. The information appears in Table 4 which was discussed earlier. The data simply provided a profile of the sample population.

The female respondents were surveyed to determine the degree of occupational commitment that they believed they would be able to demonstrate. The females were provided with six options, of which they could choose a maximum of three. The question asked at what periods in their lives they would like to be working full-time. The girls were divided by course into those enrolled in Intermediate Science, 1A1 and 2A1, and Senior Science, Biology, Chemistry, and Physics in order to obtain a comparative response between the younger and older female students. Their responses are presented in Table 12. Of greater interest than the options which involved working before marriage and after marriage before having children, were those responses involving working full-time with a family. In Table 12, these involve lines C, D, E, and F. The intermediate females seemed to favour the option of working full-time once their children were attending elementary school, that is, 5.53% (105). Very few wanted to wait until the children were finished high school. For the senior level respondents, 3.26% (62) of those enrolled in Bology courses would work full-time with children in elementary school and 1.47% (28) of those enrolled in Physics courses chose the same option. The females enrolled in Chemistry chose the option of working full-time once children could attend pre-school, 1.90% (36). The percentages here were rather low due to the fact that there were fewer senior level female respondents and possibly due to the fact that three choices could be made, leading to a greater spread. In addition, the females aspired

Table 12

A Summary of Occupational Commitment of Female Respondents

	1A1	% of N	2A1	% of N	Bio	% of N	Chem	% of N	Phys	% of N
A	195	10.27%	190	10.01%	140	7.37%	77	4.05%	44	2.32%
B	164	8.64%	166	8.74%	122	6.42%	63	3.32%	41	2.16%
C	82	4.32%	71	3.74%	61	3.21%	36	1.90%	14	0.74%
D	105	5.53%	79	4.16%	62	3.26%	33	1.74%	28	1.47%
E	21	1.11%	30	1.58%	15	0.79%	3	0.16%	1	0.05%
F	13	0.68%	10	0.53%	12	0.63%	3	0.16%	0	0.00%
G	14	0.74%	5	0.26%	6	0.32%	1	0.05%	2	0.11%

A - Before marriage
B - After marriage but before children
C - After marriage with preschool children
D - After marriage but not until children are in elementary
E - After marriage but not until children are in high school
F - After marriage when children have graduated high school
G - No response

Note: Respondents were allowed to select up to three (3) options to professional careers, which may also have played a role in the options they chose for this question. It may be feasible that these young women, while believing marriage and family to be important, are giving serious thought to their education and future career at this time in their lives, more so than giving thought to the effect that having children will have on their lives.

With this, the demographics section is complete. To recap briefly, the significant factors which were identified based on the gender responses were age, important family member, grade, sex of favourite teacher, preferred disciplines of science, career aspirations, desired age for marriage, and the importance of marriage. More about these will be addressed in the final chapter of this paper.

b) Science and science-related experiences.

Part B of the questionnaire focused on the experiences of science and the possible effects they might be imparting to science students. The respondents were asked to describe their feelings about 25 science or science-related situations. The range of responses possible was very calm, fairly calm, neutral, a little nervous, and very nervous. The underlying factor being studied in the section was science anxiety, more specifically, science anxiety as generated by situations involving testing, the direct application of principles, the general application of principles, and performance in front of others. The expectation was that certain experiences which caused anxiety for science students could be identified so that possible interventions could be suggested to alleviate such anxiety and promote science course enrolment. The questions pertinent to each of these situations were not presented sequentially. Therefore, each potentially anxiety-causing situation will be discussed based on those questions that addressed it specifically.

Science anxiety based on testing was represented by seven questions, 21, 23, 26, 31, 33, 42, and 44. The situation described in Question 21 was "starting science class." Frequencies were 29.8% (401) for very calm, 20.3% (273) for fairly calm, 30.3% (408) for neutral, 10.3% (139) for a little nervous, and 2.2% (30) for very nervous. There were 7.0% (94) missing responses. Gender responses indicated a chi-square of 31.48533 with significance 0.00001. For the male respondents, 36.1% (184) felt very calm about starting science class, 25.1% (128) felt fairly calm, 31.2% (159) felt neutral, 6.7% (34) felt a little nervous, and 1.05% (5) felt very nervous. For the female respondents, 29.3% (213) were very calm, 19.6% (143) were fairly calm, 33.6% (245) were neutral, 14.3% (104) were a little nervous, and 3.3% (24) were very nervous.

Overall, the neutral response was chosen by both sexes over the calm or nervous choices, with the males expressing a somewhat greater feeling of calm compared to the females.

Question 23 posed the situation of "studying for a science test." Frequencies were 9.7% (130) for very calm, 17.4% (234) for fairly calm, 21.5% (289) for neutral, 27.4% (369) for a little nervous, and 16.7% (224) for very nervous. The chi-square was 58.72231 with significance 0.00001. For very calm about studying for a science test, the percentage of males was 15.7 (80), 17.7% (90) chose fairly calm, 27.9% (142) chose neutral, 27.9% (142) chose a little nervous, and 10.8% (55) chose very nervous. The female respondents chose very calm 6.6% (48), fairly calm 19.7% (143), neutral 19.8% (144), a little nervous 30.9% (225), and 23.0% (167) very nervous. Again the females expressed more feelings of nervousness to this situation than the males. The males were generally calmer about studying for a science test.

The situation "taking a science test" was presented in Question 26. Response frequencies were 6.7% (90) for very calm, 12.7% (171) for fairly calm, 15.2% (204) for neutral, 32.0% (430) for a little nervous, and 26.0% (350) for very nervous. Missing responses made up 7.4% (100). It was observed that the neutral response was given less emphasis by the respondents for this situation. For the males, 10.4% (53) chose very calm, 17.4% (89) chose fairly calm, 20.0% (102)

chose neutral, 34.4% (176) chose a little nervous, and 17.85 (91) chose very nervous. For the females, 5.0% (36) chose very calm, 11.2% (81) chose fairly calm, 13.9% (101) chose neutral, 34.6% (251) chose a little nervous, and 35.3% (256) chose very nervous. There was a significant differences between responses of the males and the females as indicated by the chi-square value of 60.00717, significance 0.00001. The females appeared to be much more nervous overall about taking a test than the males in the sample.

"Taking a quiz in science" was suggested in Question 31. Frequencies were very calm 11.7% (158), fairly calm 18.1% (243), neutral 24.5% (330), a little nervous 30.5% (410), and 7.7% (104) for very nervous. Missing responses made up 7.4% (100). The chi-square was 49.89426 with significance 0.00001. The male respondents chose very calm 16.3% (83), fairly calm 20.7% (105), neutral 32.7% (166), a little nervous 26.0% (132), and very nervous 4.3% (22). The female respondents chose very 10.3% (75), fairly calm 18.6% (135), neutral 22.3% (162), a little nervous 37.7% (274), and 11.0% (80) very nervous. The males tended to feel neutral or a little nervous over taking a quiz. The females showed a tendency towards nervousness. Experience by the researcher has shown that students do not always take quizzes as seriously as larger tests, which may account for less nervousness about taking them. It can also be suggested that the responses may be influenced by the degree of ease the student feels with respect to writing a quiz. If the class is organized in such a way that quizzes are taken frequently, the student gains confidence and experience. He/she comes to expect that quizzes will be given frequently, may be more attentive on a day-to-day basis, and become subsequently more familiar and comfortable with the course content.

Question 33 presented "memorizing names of body parts for a science test." This situation did not prove to be one of significance. Possibly, by high school students are very familiar with memorization and with names of body parts, that this experience does not generate much anxiety.

In Question 42, the situation "thinking about a test one day before taking it" was offered for reaction. The frequencies were 12.2% (164) for very calm, 13.8% (186) for fairly calm, 17.2% (231) for neutral, 32.0% (431) for a little nervous, and 17.0% (228) for very nervous. The missing responses comprised 7.8% (105). This was a significant factor, 0.0001, with a chi-square of 57.70602. The responses of the males were very calm 18.8% (91), fairly calm 18.5% (93), neutral 22.1% (111), a little nervous 30.4% (153) and very nervous 10.9% (55). The females responded very calm 9.9% (72), fairly calm 12.4% (90), neutral 16.4% (119), a little nervous 38.0% (276), and very nervous 23.4% (170). Repeatedly, the mere thought of taking a test was a greater source of anxiety for the females than the males.

Along the same topic, Question 44 suggested "thinking about a test one hour before taking." For this question, the frequencies were 6.8% (91) for very calm, 10.1% (136) for fairly calm, 13.5% (182) for neutral, 30.4% (409) for a little nervous, and 31.4% (422) for very nervous. Again, 7.8% (105) were missing. The chi-square was 43.97379 with significance 0.00001. The responses of both the males and the females showed feelings of greater anxiety. The males responded 10.75 (54) very calm, 13.7% (69) fairly calm, 18.3% (92) neutral, 31.8% (160) a little nervous, and 25.4% (128) very nervous. Similarly, the females responded 5.1% (37) very calm, 9.1% (66) fairly calm, 12.3% (89) neutral, 33.8% (245) a little nervous, and 39.7% (288) very nervous. For both groups, anxiety was felt. The males expressed more calmness compared to the females and the females expressed more nervousness to this situation.

To summarize, testing in science creates anxiety for the male and female respondents. Obviously, it is understood that the science curriculum is extremely heavy, especially in senior courses. Thus, the students might be overwhelmed with information and may have some uncertainty with respect to what is most important, and what might be emphasized on a test. Furthermore, students may need to acquire more appropriate study skills to permit them more successful test scores, since the system does focus on grades. The acquisition of better preparatory skills might serve to alleviate some of the anxiety caused by tests.

There were four questions used to measure science anxiety as generated by the direct application of principles. By this is meant using particular, learned in early introductory science classes, to collect data or make observations. The skills considered were using a thermometer to measure the temperature of water in an experiment (Question 25), weighing a substance to use in an experiment (Question 32), focusing a microscope (Question 41) and lighting a Bunsen burner (Question 45). It was expected that students would have had some prior experience in performing these skills and had, therefore, mastered them.

The students were generally comfortable with the use of a thermometer and with the skill of weighing substances. This may stem from the now common use of digital analytical balances in the labs, which require very little manipulation, unlike the triple-beam and pan balances of the past.

With regard to focusing a microscope, the frequencies still revealed overall perspectives of calm to neutral. Of the total sample, 46.1% (620) were very calm about focusing a microscope, 18.0% (242) were fairly calm, 21.9% (294) were neutral, 4.5% (60) were a little nervous, and 1.6% (21) were very nervous. The missing responses made up the remaining 8.0%

(108). The gender statistics supported the frequencies. The males responded 56.5% (283) very calm, 16.8% (84) fairly calm, 21.4% (107) neutral, 3.8% (19) a little nervous, and 1.65 (8) very nervous. The females responded 45.9% (333) very calm, 21.8% (158) fairly calm, 25.2% (183) neutral, 5.4% (39) a little nervous, and 1.7% (12) very nervous. The microscope is not a strong source of anxiety, according to the pattern of response. The chi-square was 13.83560 with significance 0.0078, which suggests this skill to be a positive motivator, increasing science interest. Any anxiety caused by this skill may stem from the fact that students often require time to become familiar with every aspect of the microscope, especially in focusing properly. Some anxiety may also be caused by the thought of having to pay for any damage caused to the microscope.

Lighting a Bunsen burner proved to be one skill that could generate a higher degree of anxiety, compared to the others. Frequencies were 34.5% (464) for very calm, 16.6% (223) for fairly calm, 21.9% (295) for neutral, 13.2% (178) for a little nervous, and 6.0% (81) for very nervous. There were 7.7% (104) missing responses. The male respondents expressed overall ease about this task, responding 48.9% (244) very calm, 18.0% (90) fairly calm, 22.4% (112) neutral, 6.6% (33) a little nervous, and 4.0% (20) very nervous. the females responded 30.0% (219) very calm, 17.6% (129) fairly calm, 24.8% (171) neutral, 19.4% (142) a little nervous, and 8.2% (60) very nervous. The majority of both groups were calm to neutral about lighting a Bunsen burner. However, there was a higher degree of nervousness expressed by both groups when the other skills measured are considered. It could be that the Bunsen burner poses a greater potential physical threat, considering the gas and the open flame, rather than the actual action of lighting it.

Overall, the direct application of principles seems to generate some anxiety, at least a small percentage of the time. It seems to be dependent on the nature of the skill being performed and the potential danger in which the student is placed.

The general application of principles involves the content of science courses. The students were asked to describe the feelings they associated with being asked to explain a science topic (Question 25), visiting a science museum (Question 27), being called on in science class (Question 28), doing a science project (Question 34), writing a report for science class (Question 37), and following directions to do an experiment (Question 40). The responses to Question 25, explaining a topic in science, were 6.9% (93) for very calm, 14.7% (198) for fairly calm, 19.0% (256) for neutral, 31.4% (422) for a little nervous, and 20.4% (274) for very nervous. The missing responses were 7.6% (102). The chi-square was 33.36458 which with significance 0.00001, suggesting this to be an anxiety-causing activity for the groups in question. The response pattern of the males was

very calm	10.6% (54)
fairly calm	18.8% (96)
nervous	23.3% (119)
a little nervous	29.6% (151)
very nervous	17.6% (90)

indicating greater feelings of neutrality and nervousness over feelings of calmness. The response pattern of the female was

very calm	5.1% (37)
fairly calm	13.7% (99)
nervous	18.6% (134)
a little nervous	37.0% (267)
very nervous	25.5% (185)

comparable to that of the males yet showing even more nervousness.

Visiting a science museum was the situation posed in Question 27. The chi-square analysis did not reveal any significant differences between the males and females with the majority of the responses falling in the calm to neutral range. This experience would not be a particular source of anxiety especially if it was a visit being made out of interest rather than necessity.

To Question 28, students gave their feelings about being called on in science class. This focuses on the individual personalities and confidence levels of the students with respect to their teacher and, especially, their peers. The sample response frequencies were very calm 14.3% (193), fairly calm 21.2% (285), neutral 25.9% (349), a little nervous 23.9% (322), and very nervous 7.4% (100). The missing responses constituted 7.1% (96). The chi-square was 35.45470 with significance 0.00001. For the male portion of the study sample, the responses ranged from 19.6% (100) for very calm, to 25.3% (129) for fairly calm, to 30.1% (153) for neutral, to 20.2% (103) for a little nervous, to 4.7% (24) for very nervous. The females' responses mirrored those of the males but showed a greater tendency toward being nervous. They responded 12.8% (93) for very calm, 20.9% (152) for fairly calm, 26.3% (192) for neutral, 29.8% (217) for a little nervous, and 10.3% (75) for very nervous. This situation presented a potential source of anxiety for the females.

In Question 34, doing a science project was evaluated. This usually involves some background research using library resources, the formulation of a problem or question and the use of the scientific method to collect data and solve the problem. It will almost always involve a written report and may require an oral presentation. The respondents were aware of these requirements as their independent studies in science follow the same approach. With respect to the large sample, the frequency broke down into 15.8% (212) for very calm, 19.3% (260) for fairly calm, 28.3% (380) for neutral, 22.6% (304) for a little nervous, and 6.4% (86) for very nervous. The remaining 7.7% (103) made up the missing responses. For the males and females, this situation was significant in the generation of anxiety. The males showed an inclination towards calmness with the following responses - 17.6% (89) very calm, 23.4% (118) for fairly calm, 34.3% (173) for neutral, 18.2% (92) a little nervous, and 6.5% (33) very nervous. The females showed a lesser degrees of calmness and an inclination towards being a little nervous. Their responses broke down into 16.8% (122) for very calm, 19.4% (141) for fairly calm, 28.1% (204) for nervous, 28.6% (208) for a little nervous, and 7.2% (52) for very nervous. The chi-square was 19.48242, significance 0.0006. Doing a science project involves numerous learning and working skills, organization, preparation, and willingness on the part of the students. Naturally, since the choice is usually left to them, some anxiety over the thought of doing a project will be present right from the start. Considering the nature of science projects, it is not surprising that the respondents showed a propensity for nervousness.

Directly related, but perhaps somewhat simpler in nature, involves Question 37, writing a report for science class. This might be a lab report for an experiment or a critique of a science article of interest. It would certainly require an organized, logical presentation and proper grammatical and writing skills. The chi-square statistics did not reveal it to be a significant determiner of anxiety.

Finally, anxiety generated by general application of principles was addressed in Question 40 which asked students to respond to following directions to do an experiment. Unless students are devising their own experiments, directions are usually provided in texts or lab manuals. The responses of the samples were 26.8% (361) very calm, 24.7% (332) fairly calm, 28.4% (382) neutral, 11.4% (153) a little nervous, and 1.5% (20) very nervous. Both the males and the females expressed positive feelings to this situation. Responses for the males were 32.4% (164) very calm, 28.5% (144) fairly calm, 28.7% (145) neutral, 8.7% (44) a little nervous and 1.8% (9) very nervous. Responses for the females were 26.5% (194) very calm, 25.5% (187) fairly calm, 31.6% (231) neutral, 14.9% (109) a little nervous and 1.5% (11) very nervous. These results, and the chi-square 14.82173 (significance 0.0051) indicate that this activity is a significant one. Since the range of responses leans towards positive feelings, it could be assumed that the activity is not one that generates anxiety per se. It may be a significant factor in generating interest in science, that is, by means of performing experiments.

To review, those activities which involved oral participation in science class seemed to present the greatest degree of nervousness and, thus, anxiety. It would seem that the students are not comfortable disclosing their knowledge before their peers. This may also be related to a fear of making a mistake or being ridiculed. This is related to the classroom environment set by each teacher.

The question of whether science anxiety is generated was further examined through the questions that dealt with performance for others. There were seven questions that focused on this particular aspect, numbers 22 ,29, 30, 35, 36,38, and 43. These questions covered difference instances in which students were "performing" during science class.

The first, Question 22, involved "having someone watch you do an experiment." Frequencies for each response were 9.7% (13) very calm, 18.9% (254) fairly calm, 24.3% (327) neutral, 33.2% (447) a little nervous and 7.4% (99) very nervous. The missing responses made up the balance, 6.5% (88). The chi-square was 37.91088 with significance 0.00001. The males' responses reflected greater calmness than the females' responses. The breakdown of their responses was 12.6% (65)

very calm, 24.7% (127) fairly calm, 29.0% (149) neutral, 29.0% (149) a little nervous, and 4.7% (24) very nervous. The females responded 8.6% (63) very calm, 17.4% (127) fairly calm, 23.7% (173) neutral, 40.4% (295) a little nervous and 10.0% (73) very nervous. This shows, once again, that the females experience much more nervousness in situations of oral presentation.

The next question, #29, posed the situation of showing a classmate the results of your experiment. This situation did not result to be significant to this section.

The situation in Question 30 involved asking the teacher a question in science. Again, students were generally comfortable with this situation.

Listening to the teacher in class was the situation in Question 35. Response frequencies for very calm were 48.3% (650), for fairly calm were 15.8% (212), for neutral were 26.1% (351), for a little nervous were 1.3% (18), for very nervous were 1.3% (17). There was a percentage of 7.2% (98) missing responses. For this question, the chi-square was 15.50744, significance 0.0038. The males' responses were very calm 48.7% (347), fairly calm 21.5% (109), neutral 26.8% (136), a little nervous, 1.0% (5), and very nervous 2.0% (10) The females' responses were very calm 54.5% (398), fairly calm 14.0% (102), neutral 28.9% (211), a little nervous 1.6% (12) and very nervous 1.0% (7). In both cases, there was a very low degree of nervousness expressed by both groups. Both groups were very calm about the idea of asking their teachers questions. This is significant in a very positive way. It is indicative that the students are comfortable with their science teachers and are not hesitant to do so. This is good, keeping in mind that the sample was made up of students enrolled in advanced level courses, with high academic aspirations.

Question 36 offered the scenario of showing parents a report card, a nerve-wrenching situation for some students, but not for the sample which completed the survey. Frequencies for the sample were 23.3% (314) very calm, 15.0% (202) fairly calm, 23.6% (318) neutral, 14.6% (197) a little nervous, and 16.1% (216) very nervous. There was a percentage of 7.3% (98) missing responses. The males and females were close in their patterns of response. The male profile of response was 24.5% (124) very calm, 16.8% (85) fairly calm, 27.1% (137) neutral, 18.8% (70) a little nervous and 17.8% (90) very nervous. The female profile was 25.9% (189) very calm, 15.6% (114) fairly calm, 24.2% (177) neutral, 17.3% (126) a little nervous and 17.0% (124) very nervous. When considering only the nervous responses, 31.6% of the males and 34.3% of the females admitted to feelings of nervousness. Therefore, even students who are earning decent grades still feel some apprehension to showing report cards to their parents.

Reading a science magazine and having a friend ask you about it was the situation in Question 38. For the males and the females, this was a comfortable experience, evidenced by the bulk of responses in the very calm to neutral range.

The final question in this section offered the scenario of reading a chapter of a science book and being asked to explain it. In terms of frequency of response, 9.3% (125) of the group was very calm, 13.7% (184) of the group was fairly calm, 25.3% (340) of the group was neutral, 31.0% (417) was a little nervous, and 12.9% (174) was very nervous. Missing responses made up 7.8% (105). The chi-square of 30.09318 and significance of 0.00001 was indicative of this being an important experience. On the part of the males, 12.9% (65) felt very calm, 14.9% (75) felt fairly calm, 33.3% (168) felt neutral, 28.1% felt a little nervous and 10.9% (55) felt very nervous. On the part of the females, 8.2% (59) felt very calm, 14.9% (108) felt fairly calm, 23.5% (170) felt neutral, 37.2% (269) felt a little nervous and 16.2% (117) felt very nervous. This type of experience is not unlike that of the testing situation. The students' understanding of what was read is being challenged in two ways. First, their actual recall of the content covered in the chapter is being tested. Second, they are being asked to explain it, which might involve oral participation, a source of anxiety for females especially. In fact, the female responses did show a greater sense of nervousness compared to the males.

In a statement of overview, the section on science and science-related experiences was enlightening. It was learned that students were very nervous about taking quizzes and tests. Tests were a definite source of anxiety for the sample in question. It might be suggested that students receive more assistance in developing better test preparation strategies and to practise the strategies, increasing frequency and decreasing magnitude of tests might prove beneficial to the alleviation of some anxiety. Another source of anxiety was the use of microscopes and Bunsen burners. Greater familiarity and more experience with this type of equipment might be advantageous. Students were apprehensive about expressing themselves in class discussion situations. A possible intervention might be to use mistakes as learning tools to help students better understand concepts and ideas. Doing science projects and following directions for experiments were significant experiences in a positive way. The respondents indicated little apprehension and anxiousness about performing these activities. It can be interpreted that they present a positive and more practical science learning experience since both allow individual interest and expression of thought. Perhaps this approach to science would be more advantageous to the students in the long run. Finally, performance in front of others proved to be both negative and positive. Students were not as comfortable speaking to the class about science or being watched but were fine with listening to the teacher and discussing science articles with friends. Ultimately, the more confidence that can be built by science and science-related experiences, the greater the success that will be attained. If this type of experience becomes ongoing, more students might become interested in studying science throughout high school.

c) Science ability and attitudes.

Part C of the questionnaire allowed for a brief examination of abilities and a more extensive examination of attitudes towards science. Ability with respect to grades was addressed by two questions. Question 46 sought to determine the overall grade range of the respondents in their high school career up to the time of the administration of the questionnaire. The grades were divided into the following choice ranges:

A. mostly 85-100

B. mostly 70-84

C. mostly 60-69

D. mostly 50-59

E. mostly below 50

This would simply provide a basis to which the science grades could be compared. It might be helpful to recall that students enrolled at the advanced level are expected to meet rather high expectations as set by the curriculum and the teachers. They probably set high standards for themselves since many aspire to continue their educations at the university level and higher yet. The frequencies showed a percentage of 21.0% (282) at the 85-100 range, 48.3% (650) at the 70-84 range, 17.6% (237) at the 60-69 range, 4.4% (59) at the 50-59 range, and only 1.0% (14) below 50. Thus, the sample can be described as having a high academic profile with the majority of the respondents achieving grades in the higher mark ranges. The corresponding chi-square value of 9.80685 with significance 0.0438 provided a similar mark profile of the male and female respondents. Referring only to the top mark ranges (85-100, 70-84), 20.3% (103) of the males were achieving grades of 85-100, 50.9% (258) of the males were achieving grades in the 70-84 range. For the females, 24.4% (177) were in the 85-100 range, 53.7% (389) were in the 70-84 range. This would also give some substance to their high academic and career aspirations.

Grades in science were tabulated using responses to Question 47. The same mark ranges were provided as options. Once again, the bulk of the respondents fell into the two top categories of marks. For the large sample, frequencies found

18.1% (244) in the 85-100 mark range, 39.0% (525) in the 70-84 range, 20.3% (273) in the 60-69 range, 10.0% (134) in the 50-59 range and 5.0% (67) below 50. Over half of the population was achieving honours or close-to-honours grades. The chi-square profile for the top two categories indicated that the females were achieving somewhat higher science grades. The male respondents had 18.6% (84) in the range of 85-100 and had 40.4% (204) in the range 70-84. The females had 20.4% (148) in the 85-100 range and 43.9% (319) in the 70-84 range. It is also helpful to compare scores which might be called "average." In the 60-69 range, there were 22.0% (111) males and 21.7% (158) females. This question certainly lent itself to interpretation on the part of the students. It really took for granted that the responses would be accurate representations of the grades of the respondents. It is possible that the students were not completely candid and tried to present a rosier picture of their abilities with respect to grades. Nonetheless, the profile obtained was consistent with the earlier inferences of very high academic and career aspirations. The majority of the students were achieving top grades and the females were slightly higher overall.

Attitudes about science were measured by the motivation experienced by students through the performance of certain activities when not required for science class, the motivation generated from feeling felt during science classes, and by their observations of the effects of classroom environment. The responses possible for the performance of activities when not required for science class were:

A. often B. sometimes C. seldom D. never

There were eight items, each suggesting activities related to science that might be done even when not directly required for science class. Questions 48 and 49 dealt with the reading of science articles in magazines and newspapers respectively. In both cases, the responses were very close, with a greater part of the large group leaning towards seldom or never reading science articles just out of interest. Similar results were obtained from the male and female respondents. This is one area where students could be gaining a great deal of knowledge about more recent developments in science. It would provide an excellent vehicle for classroom discussions and questioning.

Certainly the idea of keeping abreast of current scientific developments was better received if it involved watching science programs on television. For this activity the frequencies are somewhat higher for the often and sometimes categories, perhaps indicating preference for watching TV versus reading. Overall, 13.1% (176) watched often, 31.5% (424) watched sometimes, 24.1% (324) watched seldom, and 21.5%

(289) never watched. This activity proved to be a meaningful one with a chi-square of 19.94933 and significance 0.0005. The male profile showed 18.8% (94) watching science programs often, 34.9% (174) sometimes, 25.5% (127) seldom, and 20.0% (100) never. The profile for the females showed 11.2% (8) watching often, 34.1% (247) sometimes, 26.8% (194) seldom, and 25.7% (186) never. This reveals a preference for this form of presentation. The television can "show" the students more graphically, ideas and concepts that a magazine or newspaper article cannot. It is also more readily available to most students than subscriptions to scientific magazines.

Attending science lectures was the activity suggested in Question 51. It could be that this particular avenue has never really been identified by high school teachers for their students as it did not reveal itself to be a significant factor. Presuming the lectures are being offered at local universities unless there was particular interest in keeping track of presentations that would be meaningful to secondary science students, the students themselves would have no awareness of their existence.

The next activity involved reading books about science or scientists and was found in Question 52. Response frequencies were 4.8% (65) reading often, 17.4% (234) reading sometimes, 31.2% (419) reading seldom and 36.1% (486) never reading. The males read books about science or scientists often at 7.1% (36), sometimes at 21.8% (110), seldom at 34.1% (172) and never at 35.2% (178). Books about science or scientists were read often by 3.9% (28) of the females, sometimes by 16.9% (122), seldom by 33.9% (244), and never by 42.1% (303). Why has reading become so disliked by high school students? The ideas and information that are available are phenomenal and do not seem to be used as extensively as they might be by high school students. Even as a tool for improvement of vocabulary, reading books about science is most valuable.

With respect to talking to friends about science topics, no real significance was revealed. It is possible that they have done this but not in a conscious way. That is, all students have talked at some point about A.I.D.S., abortions, pollution, the ozone layer and so on. This may not have been clear to the respondents at the time they were completing the questionnaire. Talking to students reveals that they are familiar with current science issues. The question may have been interpreted as referring to concepts and theories as opposed to topics.

Question 54 referred to doing science projects when not required for science classes. Again, the respondents may have forgotten about the latter part of the question when making their responses in this section. Frequencies for having done science projects were 19.5% (262) for often, 32.1% (432) for sometimes, 17.6% (237) for seldom, and 19.4% (261) for never. Projects were shown to be popular among the students and the breakdown of responses would appear to support this. Overall, 18.8% (93) of the males had done projects often, 38.8% (192) sometimes, 22.0% (109) seldom, and 19.2% (95) had never done science projects when not required for class. Of the female respondents, 23.4% (165) did projects often, 33.6% (237) did projects sometimes, 17.7% (125) seldom did projects, and 23.4% (165) never did projects when not required for science class. Thus, a little over half of the respondents admitted having done science projects. Again, it should be reiterated that the activities in question were being performed at times other than those directly involving science classes, a point which may have been ignored for this particular question. Despite this, projects are significant positive science experiences for the students.

Lastly, Question 55 offered the activity of having worked with science-related hobbies. Frequencies were 6.3% (85) often, 22.7% (305) sometimes, 29.8% (401) seldom, and 29.5% (397) never. The chi-square was 34.26274 with significance 0.00001. The male responses were 11.5% (58) often, 28.9% (146) sometimes, 30.6% (155) seldom, and 26.9% (136) never. The females responded 5.3% (38) often, 20.3% (146) sometimes, 35.2% (253) seldom, and 36.6% (263) never. The respondents were clearly not avid science-related hobbyists. Reasons for this may be attributed to greater academic and extra curricular involvements, and part-time jobs, leaving little time for hobbies as such. Also a factor might be the reluctance to admit to having a hobby of this nature, which was difficult to measure on this questionnaire. Personal interviews might have provided more evidence of science-related hobbies but unfortunately this avenue was not pursued.

In summary, it can be stated that little motivation is being derived from reading magazines and newspaper articles and books about science and scientists, attending lectures, talking with friends, and working with science related hobbies. The only real motivating element revealed here was watching science programs and, to a certain extent, doing science projects. The students were not performing most of the activities out of general interest, as indicated by the response patterns. It might be suggested that science and science related topics could be extended to non-science areas of study in the high schools in order to allow students to relate what they learn in science to instances not directly related to science. An analogy of this is the use of reading and writing skills learned by studying English, in all areas of learning besides the English class. With respect to attending lectures, the universities could be improving communications with secondary science classes by offering schedules of speakers, invitations for tours, and information sessions aimed at secondary students.

The next six questions on the instrument were designed to obtain a sense of how the students feel during science classes as a measure of motivation. The responses available were

A. always
B. often
C. sometimes
D. seldom
E. never

and the feelings in question were uncomfortable, curious, stupid, confident, successful and unhappy. These were presented in the order they appear but will be discussed in terms of positive (curious, confident, successful) and negative (uncomfortable, stupid, unhappy).

The positive feelings were presented in Questions 57, 59, and 60. There was a positive feeling about curiosity expressed by both groups but it was not a significant motivating factor.

In Question 59, students responded to frequency of feeling confident in science class. The overall group responded as follows: always 4.6% (62), often 21.3% (286), sometimes 39.3% (529), seldom 20.7% (278), and never 6.5% (88). Being made to feel confident was a significant motivating factor as indicated by the chi-square of 34.53208, significance 0.00001. An examination of the responses of the males revealed that science classes made them feel confident always 8.3% (42), often 27.3% (138), sometimes 40.7% (206), seldom 18.2% (92) and never 5.5% (28). The responses of the females were always 2.8% (20), often 20.0% (145), sometimes 44.4% (322), seldom 24.8% (180) and never 8.0% (58). In comparison, the males showed a slightly greater tendency towards experiencing confidence than the females. The interesting aspect of this data is the large percentage of males and females experiencing feelings of confidence only sometimes. Seemingly, if greater confidence were instilled, motivation would probably be greater as well. How often have science classes made you feel successful? was asked in Question 60, which is closely related to levels of confidence; one breeds the other. In this case, 5.1% (68) of the respondents answered always, 26.8% (360) answered often, 38.1% (512) answered sometimes, 14.7% (198) answered seldom and 7.4% (99) answered never. In the more frequent responses, the males showed a greater inclination towards always and often experiencing success than did the females: 7.8% (39) and 32.6% (164) versus 4.0% (29) and 26.8% (194). The males responded sometimes 37.0% (186), seldom 15.3% (77) and never 7.4% (37). The females answered sometimes 44.4% (321), seldom 16.5% (119) and never 8.3% (60). If the students are to become motivated by science, there is a definite need for them to have more experiences and opportunities that will instill feelings of confidence and successfulness.

The negative feelings that might be experienced as a result of science classes were found in Questions 56, 58 and 61. Overall, the tendency seems to favour feeling comfortable in science class, with the greater range of responses falling between sometimes and never. This is suggestive of a positive motivating factor drawing students to science. This might be related to the teacher, the type of learning environment, and the make-up of the class in terms of the students in it.

How often have science classes made you feel stupid? was posed in Question 58. Again, the frequencies showed a tendency away from these feelings with only 5.2% (70) answering always, 10.3% (138) answering often, 25.0% (343) answering sometimes, 28.8% (387) answering seldom and 22.5% (303) answering never. The significance of this factor was elucidated by the gender group responses. The responses of the males were:

6.2% (31)	always
8.2% (41)	often
24.1% (121)	sometimes
31.3% (157)	seldom
30.3% (152)	never

and those of the females were:

5.1% (37)	always
13.1% (95)	often
30.2% (219)	sometimes
30.9% (224)	seldom
20.7% (150)	never

The students must be feeling challenged and intelligent judging by the patterns of response, with over 80% of the male and female respondents falling into the sometimes to never range. It would be pleasant to see the percentage for sometimes decrease nevertheless. More females than males admitted that science classes sometimes made them feel stupid.

Lastly the unhappy feeling was examined in Question 61. The responses ranged from 4.9% (66) responding always, 10.2% (137) responding often, 23.4% (315) responding sometimes, 303% (408) responding seldom, to 22.8% (307) responding never. Overall, the males fell into the sometimes to never categories by 84.3% (423) and 83.6% (601) of the females fell into the same categories. This is an indication that the students are happy most of the time during science classes.

To summarize, the students indicated very positive feelings overall as experienced during science classes. They were somewhat confident and successful, moderately curious, and generally comfortable, challenged and happy, or at least satisfied. Thus, the positive tone that must exist for these respondents must be playing an important contribution to their motivation to continue to study science, since such a positive attitude was expressed.

The remaining five questions in this section on science abilities and attitudes sought agreement or disagreement about feelings generated by the classroom environment. The responses ranged from strongly agree to undecided to strongly disagree. Question 62 posed the statement, "I usually have been at ease during science tests." The gender responses revealed general agreement with this statement. However, the females were almost evenly divided between agreement and disagreement, which seems likely due to the fact that they felt greater overall testing anxiety.

"I look forward to attending science classes" was offered for comment in Question 63. The students showed overall agreement to the statement. Interestingly, 29% of both groups were undecided about this question. It might have ended up differently if the "undecided" option had not been offered since it provides the opportunity to avoid making a definite choice.

In Question 64, "I feel uneasy about doing science labs" was suggested for response. Since students seemed to show a preference for performing labs, it was expected that the response would be one of disagreement. The responses of the mixed group were 3.9% (52) that strongly agreed, 15.4% (207) that agreed, 21.3% (286) that were undecided, 38.2% (514) that disagreed, and 13.0% (175) that strongly disagreed. The gender responses showed females disagreeing to the statement with somewhat greater emphasis than the males, with 57.4% (411) disagreeing versus 54.1% (273) of the males. There were still 23% undecided for each group. Thus, the expectation of a statement of disagreement was met. The students are at ease, generally, doing labs.

Similarly, Question 65 requested response to the statement, "I enjoy science and science projects." Both were identified by students as primary favourite subject and positive science experience in earlier questions. In the undecided category were about 20% of each group. Perhaps the combination of the two areas made the question difficult to answer, especially if students liked science but disliked projects or vice versa. In retrospect, two questions should have been asked in the place of one.

The final classroom environment question stated, "I do not enjoy working science problems." Again, the gender groups were almost evenly divided, aside from the 28% who remained undecided. Agreement was expressed by 33.4% of the males and 33.1% of the females. Disagreement was expressed by 38.9% of the males and 39.4% of the females. Personal preference for problem-solving, probably interpreted as pen-and-paper problems rather than experimental problems, would influence the outcome of the response to this question.

To recapitulate, there was no significant factor identified with respect to classroom environment other than feelings of ease during test situations. The classroom environment might have been better investigated using difference scenarios and possibly descriptions of classroom designs and situations.

d) Women in science.

Part D of the questionnaire was given this heading but incorporated a number of areas of interest. In addition to women in science (Questions 67-82), perceptions of the usefulness of science (83-86), willingness to participate in science (87-92) and perception of teacher influence (93-97) were investigated.

Probably of greatest interest and pertinence to this study was the section on impressions about females in science. Of the 16 statements offered, seven were written as definite "pro-male." This provided opportunities for each to be rebuked by the respondents. They were found in Questions 67, 69, 71 ,73, 75, 76 and 78 and will be considered first in this discussion. Once again, responses of agreement (A and B), uncertainty (C), and disagreement (D and E) were available.

Frequencies and gender statistics for each statement will be presented first and a discussion of the implications will follow. For Question 67, men need to know more about science than women, frequency of response was:

6.5% (88)	strongly agree
3.8% (51)	agree
9.7% (131)	uncertain
24.2% (325)	disagree
47.9% (644)	strongly disagree

The response of the males who strongly agreed was 14.3% (67), agree 6.6% (33), uncertain 15.2% (76), disagree 36.5% (183) and strongly disagree 28.3% (142). The females were 2.8% (20) strongly agree, 2.3% (17) agree, 7.4% (54) uncertain, 19.0% (138) disagree and 68.4% (496) strongly disagree. The chi-square was 202.80587, significance 0.00001.

For Question 69, science is more for males than females, the frequency response was:

5.7% (76)	strongly agree
5.1% (69)	agree
6.8% (92)	uncertain
19.6% (263)	disagree

54.5 (733)	strongly disagree

The response for males were strongly agree 11.2% (56), agree 12.0% (60), uncertain 13.1% (65), disagree 32.7% (163), and strongly disagree 30.9% (154). The females were strongly agree 2.8% (20), agree 1.2% (9), uncertain, 3.6% (26), disagree 13.8% (100), and strongly disagree 78.6% (568). The chi-square was 292.41202, significance 0.00001.

For Question 71, working with advanced technology is more for males than females, the frequency response was:

6.8% (92)	strongly agree
6.0% (82)	agree
7.9% (106)	uncertain
19.1% (257)	disagree
52.2% (702)	strongly disagree

The response for males was strongly agree 13.1% (66), agree 12.5% (63), uncertain 14.3% (72), disagree 31.2% (157), and strongly disagree 28.8% (145). The females were strongly agree 3.3% (24), agree 2.5% (18), uncertain, 4.6% (33), disagree 13.7% (99), and strongly disagree 75.9% (548). The chi-square was 276.26041, significance 0.00001.

For Question 75, men do not like to work for women supervisors the frequency response was:

23.9% (322)	strongly agree
27.2% (366)	agree
27.4% (369)	uncertain
7.3% (98)	disagree
5.4% (73)	strongly disagree

The response for males was strongly agree 29.3% (146), agree 24.3% (121), uncertain 26.7% (133), disagree 11.8% (59), and strongly disagree 7.8% (39). The females' responses were strongly agree 23.8% (171), agree 33.7% (242), uncertain, 32.3% (232), disagree 5.4% (39), and strongly disagree 4.7% (34). Chi-square was 34.92152, significance 0.00001.

For Question 76, women should stick to "women's jobs", the frequency response was:

7.8% (105)	strongly agree
4.3% (58)	agree
5.5% (74)	uncertain
15.3% (206)	disagree
59.3% (797)	strongly disagree

The response for males was strongly agree 15.2% (77), agree 8.5% (43), uncertain 12.3% (62), disagree 31.5% (159), and strongly disagree 32.5% (164). The response for females was strongly agree 3.6% (26), agree 1.9% (14), uncertain, 1.5%

(11), disagree 6.4% (46), and strongly disagree 86.5% (624). The chi-square was 380.19873, significance 0.00001.

For Question 78, education is wasted on women since they usually get married and raise a family, the frequency response was:

5.8%	(78)	strongly agree
4.8%	(64)	agree
8.5%	(114)	uncertain
16.7%	(225)	disagree
56.1%	(755)	strongly disagree

The response for males who strongly agreed was 10.2% (51), agree 10.8% (54), uncertain 17.3% (87), disagree 32.9% (165) and strongly disagree 28.9% (145). For females, 3.6% (26) strongly agreed, 1.4% (10) agreed, 3.6% (26) uncertain, 8.0% (58) disagree, and 83.4% (601) strongly disagree. The chi-square was 374.15291, significance 0.00001.

All of the statements were found to be highly significant in the impressions of women in science section. In every case, the respondents were shown to rebuke the statements. Especially interesting were the extremely strong feelings expressed by the female respondents for all of the questions with exception of Question 75 regarding men who dis<u>l</u>ike working for women supervisors. The girls show that they feel strongly that science can play an important part of their lives if they choose to make it a part of their lives. They were shown to demonstrate open-mindedness and firm beliefs about their roles as women. For the most part, the males were also open-minded about the role of women in science. They supported the refusal of the pro-male statements and lent support to the belief that women are as capable as men. This relevance was very exciting. It shows a much needed transition away from the old belief that a "woman's place is in the home" and offers credibility to the idea that girls must be encouraged and motivated towards science study on a regular basis if they are to realize the benefits of a career in the field.

The balance of the statements were worded in such a way as to place the emphasis on the women rather than the men. Questions like this included 68, 70, 72, 74, 77, 79, 80 and 81. Question 82 was not actually a question; it was numbered but the statement was actually part of number 81, therefore it will not be treated as a separate question. In fact, many answered it twice, in the same way. The statistics will be offered first.

Girls can do just as well as boys in science (68):

	Response Frequency	Males	Females
A.	62.6% (842)	41.8% (207)	87.3% (625)

B.	16.5% (222)	31.5% (156)	9.1% (65)
C.	4.0% (54)	9.3% (46)	1.1% (8)
D.	3.0% (40)	7.1% (35)	0.6% (4)
E.	4.9% (60)	10.3% (51)	2.0% (14)

The chi-square was 289.21975, significance 0.00001.

For "science careers are just as appropriate for women as for men" (70):

A.	59.0% (793)	39.4% (197)	82.1% (588)
B.	18.9% (254)	34.2% (171)	11.5% (82)
C.	5.7% (77)	11.6% (58)	2.5% (18)
D.	3.3% (44)	6.8% (34)	1.4% (10)
E.	4.5% (61)	8.0% (40)	2.5% (18)

The chi-square was 237.68065, significance 0.00001.

For "studying about science is just as important for females as for males" (72):

A.	58.2% (783)	39.8% (199)	79.9% (575)
B.	20.0% (269)	35.8% (179)	12.5% (90)
C.	5.4% (73)	10.4% (52)	2.9% (21)
D.	3.4% (46)	6.8% (34)	1.7% (12)
E.	8.5% (60)	7.2% (36)	3.1% (22)

The chi-square was 206.20099, significance 0.00001.

For "women are as interested in science as are men" (74):

A.	39.1% (526)	26.0% (131)	53.7% (387)
B.	24.3% (327)	31.5% (159)	23.0% (166)
C.	18.2% (245)	25.0% (126)	16.5% (119)
D.	5.8% (78)	10.5% (53)	3.3% (24)
E.	4.5% (61)	6.9% (35)	3.5% (25)

The chi-square was 104.28944, significance 0.00001.

For "women have as much science ability as men do" (77):

A.	55.8% (750)	33.5% (169)	79.3% (573)
B.	21.3% (287)	36.1% (182)	14.4% (104)
C.	7.7% (103)	15.7% (79)	3.2% (23)
D.	2.8% (37)	6.5% (33)	0.6% (4)
E.	4.6% (62)	8.1% (41)	2.6% (19)

The chi-square was 272.37066, significance 0.00001.

For "women have the ability and endurance to make successful space flights" (79):

A.	44.8% (603)	22.8% (113)	67.5% (482)
B.	24.1% (324)	35.7% (177)	20.3% (145)
C.	14.6% (197)	26.5% (131)	9.3% (64)
D.	2.9% (39)	5.8% (29)	1.4% (10)
E.	4.5% (60)	9.3% (46)	1.8% (13)

The chi-square was 251.64906, significance 0.00001

For "according to census data, equal opportunities have now been achieved" (80):

A.	11.7% (158)	12.7% (64)	12.8% (82)
B.	20.5% (276)	23.6% (110)	21.6% (155)
C.	37.5% (504)	39.3% (198)	42.1% (302)
D.	15.2% (205)	16.5% (83)	16.7% (120)
E.	6.9% (93)	7.9% (40)	6.8% (49)

The chi-square was 1.6478, significance 0.8061.

For "I would choose for myself the best qualified dentist regardless of sex" (81):

A.	49.9% (671)	48.2% (240)	60.3% (423)
B.	25.0% (336)	30.3% (151)	26.2% (184)
C.	9.9% (133)	13.5% (67)	9.1% (64)
D.	3.3% (45)	5.4% (27)	2.4% (17)
E.	2.1% (28)	2.6% (13)	2.0% (14)

The chi-square was 22.09919, significance 0.0002.

With the exception of Question 80 about achieving equal opportunities, all of the findings were statistically significant. Both the males and the females expressed agreement with all of the statements. The females, again, provided evidence of extremely strong beliefs in the role of women in science especially when compared to the degree of agreement of the males. The female respondents gave support to their increased interest and perceived abilities in science. The respondents were also unbiased in choosing a qualified dentist, regardless of sex.

Impressions about the usefulness of science were explored in Questions 83, 84, 85, and 86. The first statement was "Science classes are useful". While the statement was not statistically significant (chi-square 9.30341, significance 0.0539) it does disclose an appreciation of the importance of what is being taught in science.

Along these lines was the statement that "The things you learn in science have nothing to do with the real world" in Question 84. For this statement, as expected, general disagreement was expressed. Frequencies were as follows: strongly agree 4.5% (61), agree 5.1% (69), uncertain 14.1% (1889), disagree 33.2% (447) and strongly disagree 34.3% (461). An appreciation of the usefulness of what is learned in science was evidenced by the males, of whom 6.8% (34) strongly agreed with the statement, 8.5% (42) agreed, 18.3% (91) were uncertain about it, 31.4% (156) disagreed, and 35.0% (174) strongly disagreed. Similarly, the females expressed disagreement at an even higher degree with only 3.4% (24) strongly agreeing, 3.8% (27) agreeing, 13.6% (97) expressing uncertainty, 39.9% (285) disagreeing, and 39.4% (282) strongly disagreeing. This indicates a general belief that their science skills and concepts learned in class are applicable in the real world. It might even be suggested that the respondents had a good awareness of the fact that science takes on a problem-solving approach which will help them to continue to do so in the future, regardless of career choice, because of the development of that particular thought process over the years.

This was also supported by the response to Question 86 which stated, "Most of what you learn in science class will be useful." The large sample responded strongly agree, 21.5% (289), agree, 35.0% (471), uncertain, 24.1% (324), disagree, 6.7% (90), and strongly disagree, 3.9% (53). The male/female breakdown indicated that, of the males, 57.6% (291) agreed, of the females, 64.9% (461) agreed, but about 26% of each chose uncertain as their responses to the statement. Still, general support was revealed. The students are aware of the need for science in their lives and it is believed that as they further pursue science education, this reality becomes even clearer.

To further test whether the respondents really believed science to be important, the question in 85 stated, "Science should be required throughout high school". To this is seen a greater spread of response as 16.2% (218) strongly agreed, 21.0% (282) agreed, 24.8% (334) were uncertain, 18.4% (247) disagreed, and 9.7% (131) strongly disagreed. To compare the responses of the males and the females the following is offered:

	Males	Females
Strongly Agreed	19.3% (97)	16.8% (117)
Agree	22.7% (114)	23.9% (167)
Uncertain	26.1% (131)	28.4% (198)
Disagree	18.9% (95)	21.6% (151)
Strongly Disagree	12.9% (65)	9.3% (65)

For males, there is 42% agreement versus 31.8% disagreement. For the females, there is 40.7% agreement versus 30.9% disagreement. Although 26%-28% were uncertain, there is still a greater tendency towards agreement that science should be required throughout high school. To play devil's advocate momentarily, at the present time, those students who enrol in senior science courses do so by choice. That is, they are enrolled in science courses beyond the two required for a high school diploma. Therefore, they are interested. They must have some awareness of the advantages and benefits of enroling in high school science beyond the intermediate level. Chances are they realize the value that science will be to their future. With this in mind, forcing the issue may destroy this awareness and willingness to study and succeed in senior science courses. This idea is simply offered as food for thought and does not reflect the ideas of the respondents in any way.

The participation of students in science was evaluated by

Questions 87, 88, 89, 90, 91, and 92. The respondents were asked about their impressions of science classes in order to determine if any changes in the nature of these classes were necessary. Students were able to respond always, often, sometimes, seldom or never to each question.

Question 87 asked, "How often are science classes boring?" Responses of the large group were 11.4% (154) for always, 22.4% (301) for often, 39.0% (524) for sometimes, 15.2% (205) for seldom, and 3.0% (40) for never. An examination of the gender statistics yielded the following: for males, 19.4% (96) answered always, 24.1% (119) answered often, 38.5% (190) answered sometimes, 14.2% (70) answered seldom, and 3.8% (19) answered never. For the females, 7.8% (56) responded always, 24.7% (177) responded often, 46.0% (330) responded sometimes, 18.7% (134) responded seldom, and 2.8% (20) responded never.

In comparison, Question 88 asked, "How often are science classes interesting and fun?" Frequencies for the group as a whole were 4.5% (61) responding always, 29.3% (394) responding often, 34.8% (468) responding sometimes, 16.5% (222) responding seldom and 6.2% (83) responding never. The chi-square was 19.87955, significance 0.0005. The responses for the males and the females were as follows:

	Males	Females
Always	5.1% (25)	5.0% (36)
Often	29.4% (145)	34.5% (249)
Sometimes	36.6% (181)	39.1% (282)
Seldom	18.6% (92)	17.3% (125)
Never	10.3% (51)	4.2% (30)

The highest range was in the often and sometimes category for classes that were interesting and fun. For boring classes, the highest responses fell into the categories of often and sometimes with a higher percentage in the always category. This is not terribly consistent with the interest in science that was expressed earlier. Perhaps students have come to expect too much from science classes, causing their expectations to be quite high when, in fact, the nature of the curriculum makes it difficult at times to achieve the interesting and fun expectation. There are ways to increase the interest levels, nevertheless. A more hands-on or experimental approach is often helpful because students test or discover concepts for themselves. Also, peer presentations and group work are useful in changing the classroom atmosphere.

The next question asked, "How often do you like going to science class?" The emphasis was to be on the enjoyment of going rather than the frequency of going to science class.

While not terribly significant statistically, it does emphasize a general willingness towards going to science classes.

Questions 90 and 91 dealt with participation in science class as 90 asked, "How often are you afraid to ask questions in science class?", and 91 asked, "How often are you reluctant to answer questions in science class?" This goes along with earlier questions which determined presence of science anxiety which revealed that speaking in science class did create nervousness for the respondents as a whole. There was no significant difference in the responses of males and females. The majority of responses fell into the sometimes to never category for both. Since a question was simply being asked and no oral test of knowledge was involved, this seems to be a logical response.

The outcome of reluctance to answer questions was similar. There was no significant statistical difference between the responses of the males and the females, the majority falling between the categories of sometimes to never. The findings are interesting in light of the nervousness felt about oral participation. However, since questions allow for learning and usually focus on small amounts of information, it does not seem unusual to see these results. It might even be indicative of the fact that students are highly encouraged to ask questions and seek clarification in science classes.

The remaining question evaluating participation asked, "How often are the things you studied in science class too difficult?" The male/female differences were not statistically significant since the major part of the group chose responses in the sometimes to never categories. This indicates that the content may be challenging at times but not to the point where it is causing extreme difficulties. The respondents were enrolled in advanced level courses and were aware of the nature of the courses and the expectations that accompanied them.

To summarize, the respondents showed a volition to participate in science. They were honest enough to admit to feeling a degree of boredom some of the time but were inclined to enjoy the class and take part freely in question and answer situations. It should be repeated that the senior respondents chose to study science beyond the two required intermediate level courses so it is expected that their participation is imminent.

One further aspect of the respondents' impressions of science focused on the influence of the teacher. Earlier, it was shown that the males had a tendency to favour male teachers and the females had a tendency to favour female teachers. In terms of the subjects taught by favourite teachers, for both groups science and math were the top two subjects. So the influence of teachers seemed to be a logical yet necessary factor to examine. The questions that were posed, 93 to 97, were as follows:

How often have science teachers...

(93) encouraged you to express your opinion?

(94) recognized your right to have an opinion of your own?

(95) admitted that they did not know the answer to a question?

(96) encouraged you to think for yourself?

(97) taken a personal interest in your success in science?

Question 93 did not yield a statistically significant response from the male and female respondents. An overall favourable tendency is seen towards being encouraged to express opinions.

Recognition of the right to having an opinion did turn out to be statistically significant. The large sample responded 16.0% (215) to always, 26.1% (351) to often, 27.2% (366) to sometimes, 14.6% (197) to seldom and 6.8% (92) to never. The chi-square was 9.77521 significance 0.0444. The profile of responses of the males was 13.5% (91) always, 26.9% (132) often, 27.5% (135) sometimes, 17.1% (84) seldom, and 10.0% (49) never. The profile for the females was 17.2% (123) always, 30.3% (217) often, 31.4% (225) sometimes, 15.1% (108)

seldom, and 6.0% (43) never. Clearly, this aspect of the teacher's influence is important to the respondents, who expressed overall frequency to being recognized for having an opinion of their own.

Knowledge was ranked eighth in the ten characteristics of preferred teachers, so Question 95 was expected to yield an interesting response. The response frequencies were 8.6% (116) always, 14.6% (197) often, 27.0(363) sometimes, 23.2% (312) seldom, and 16.1% (217) never. The males and females tended to follow the same pattern indicating sometimes to never to a higher degree than always and often. Grouping seldom and never, 46.5% (227) of the males and 42.0% (296) of the females felt that science teachers were very reluctant to admit to not knowing an answer to a question. For the most part, even when teachers are unable to provide an immediate response they are apt to provide an answer at some point. It could be possible that the teachers of the respondents are never at a loss for answers, hence eliminating the need to admit to not knowing the answer. Regardless, this aspect seems to be important to the students. Perhaps this quality makes the science teacher more human and humble in their eyes: that is, susceptible to errors and more like the students themselves.

The last two questions, 96 and 97 were not statistically significant in terms of the males and females. The support shown by the responses highlights the presence of this aspect of teacher influence in the sample being studied. With respect to "taking a personal interest in you," the bulk of the male/female responses fell into the categories of often to seldom with a small percentage falling into the two extremes (10% and 15%). Due to class size and physical set-up of the room, it may become difficult for teachers to take a personal interest in the success of each student but it can be surmised that the ultimate goal of the teacher is to guide his/her students to a successful end in his/her science classes, using whatever means necessary.

Thus, it has been shown that the influence of the science teacher is significant to the respondents, especially in the recognition of their right to opinions and in the admission of lack of knowledge at least once in a while. They appear to favour science teachers who encourage expression of ideas and opinions, who stress individual thought processes and who are interested in the achievement and success of the students.

In Part D of the questionnaire, the students revealed their beliefs in the value of science to their lives. In Part E, this is further explored by focusing on the importance of seven science skills involving reading with understanding, interpreting data, gathering data, observing, problem-solving using the scientific method and classifying evaluating worthiness of information. These were found in Questions 98 to 104. Of the seven skills, five were given more significance by the respondents. The range of responses was extremely important, very important, important, somewhat important, and unimportant. (A-E). Reading with understanding yielded a response of extremely important by 15.8% (212), very important by 18.0% (242), important by 31.4% (422), somewhat important by 18.7% (252) and unimportant by 6.2% (84). The importance was stressed overall by 92.1% of the males and 93.8% of the females, even though many did not express a real enjoyment of reading science and science-related materials.

Interpretation of tables, charts, and graphs received responses of extremely important by 17.6% (237), very important by 22.0% (296), important by 30.9% (416), somewhat important by 14.2% (191) and unimportant by 4.3% (58). The skill proved to elicit a statistically significant response when males and females were compared. The males called this skill extremely important 21.2% (103), very important 25.6% (125), important 32.0% (156), somewhat important 14.8% (72), and unimportant 6.6% (32). The females responded 18.8% (131) extremely important, 24.0% (167) very important, 36.7% (256) important, 17.1% (119) somewhat important, and 3.4% (24) unimportant. The fact that this skill was found to be so important makes it one that should continue to be emphasized. Furthermore, it is a skill that can be extended to areas of study other than science.

The next skill involves measuring, weighing and taking readings from instruments accurately. This was felt to be an important skill with 25.8% (347) calling it extremely important, 24.2% (325) calling it very important, 25.6% (344) calling it important, 11.7% (157), calling it somewhat important, and 3.3% calling it unimportant. The chi-square was 9.74008, significance 0.0450. The following are the breakdowns for the males (1st column) and the females (2nd column):

Extremely Important	27.9% (136)	29.4% (208)
Very Important	29.3% (143)	24.7% (177)
Important	25.0% (122)	30.4% (218)
Somewhat Important	12.7% (62)	13.1% (94)
Unimportant	5.1% (25)	2.8% (20)

These responses are indicative firstly of familiarity with the actual tasks and secondly the students' perception of their usefulness in the science class and as a skill worthwhile for them to acquire for the future.

To observe accurately was posed in Question 101. Since observations can be quantitative, involving measurements and numbers, or qualitative involving the senses, it would be expected to be an important skill. The frequencies supported its important. The male/female responses were consistent with the frequencies but not statistically significant. The respondents must be aware that observation plays a key part of experimentation using the scientific method.

The use of the scientific method of problem-solving was expected to be stated as highly important. The frequencies were 17.3% (233) extremely important, 26.2% (352) very important, 28.3% (381) important, 12.3% (166) somewhat important and 4.8% (64) unimportant. The male/female data revealed a statistical difference between them (0.0113) in a favourable manner. The profiles for males and females respectively were

Extremely Important	23.0% (111)	17.2% (121)
Very Important	30.2% (146)	29.1% (204)
Important	27.1% (131)	35.0% (246)
Somewhat Important	13.3% (64)	14.2% (100)
Unimportant	6.4% (31)	4.4% (31)

indicating a slightly higher degree of overall importance by the females. Students realize that they use the scientific method to complete experiments in science class but are not always aware that it can be used to solve almost any problem. In cases where a particular problem, not necessarily science-related, like getting a flat tire on the way to a dance, is given, students can be guided through it using the scientific method to arrive at a final solution. This method has been used by the researcher in a classroom situation often and it is always eye-opening to the students to find out that they are using the scientific method subconsciously. Its importance and worthiness as a useful skill to acquire are certainly not surprising.

The skill of classification was also considered important based on the responses to Question 103. That this was extremely important was chosen by 13.6% (183), very important was chosen by 23.0% (310), important was chosen by 34.5% (464), somewhat important was chosen by 14.6% (196) and unimportant was chosen by 3.8% (51). A statistical significance of 0.0179 was associated with the male/female responses. A percentage of 18.3 (88) found it extremely important, 24.6% (118) found it very important, 34.6% (166) found it important, 16.9% (81) found it somewhat important and 5.6% (27) found it unimportant. In comparison, the females considered it extremely important 13.3% (95), very important 26.7% (190), important 41.0% (292), somewhat important 15.6% (111) and unimportant 3.4% (24). Again, a favourable difference in support of the worthiness of this skill was shown.

The final skill which was presented was to evaluate, judge the worth of the facts, the tests, and the conclusions of scientific data. This skill yielded the greatest degree of significance, 0.0074 of all the skills. In terms of the responses of the large sample, 23.6% (317) chose extremely important, 24.4% (328) chose very important, 26.0% (350) chose important, 8.8% (119) chose somewhat important and 3.3% (44) chose unimportant. The male breakdown (1st column) is compared to that of the females (2nd column):

Extremely Important	29.2% (136)	26.5% (180)
Very Important	29.0% (135)	28.1% (191)
Important	24.7% (115)	33.6% (228)
Somewhat Important	12.9% (60)	8.5% (58)
Unimportant	4.3% (20)	3.2% (22)

It shows a greater emphasis on the top three categories of importance, more so for the females than the males, but highly worthwhile by both nonetheless.

The skills presented were found to be considered worthwhile by the sample. This is a significant outcome because it may reveal that they have given some thought to what they have been doing in science class and have come to understand that part of that learning is permitting the acquisition of very useful life skills, not just science skills. The skills are applicable to many situations, in and out of the classroom. It is heartening to learn that they feel so strongly.

The questionnaire ended with an open-ended question about scientists. Respondents were asked to identify a typical scientist. This question certainly evoked the most creative (drawings), humorous (descriptions) and sometimes "warped" (unsuitable for print) responses. Furthermore, many students did not provide a response, citing that it asked them to stereotype. This was fair, the question might have been worded differently to avoid this.

A more gender-balanced image might have been elicited had the question been worded differently. Ideas in the question that might have sparked an image about what a scientist wears at work or at home, or the various skills he/she might possess to do the job successfully, or the kinds of activities he/she might do during leisure time, might have been included (Gardner, Mason, and Matyas, 1989).

An overview of the respondents' impressions concerning the gender and age of a typical scientist was obtained. For the most part, the scientist was identified as being male (52.0%) but some stated a scientist could be either (41.95%). With regard to age, the scientist was perceived to be middle-aged (50.97%) or older (26.83%). More females than males (10.77% versus 4.04%) perceived that a scientist could be any age. Could this also be a reflection of their very strong feelings about women's abilities in science?

Generally, a number of common characteristics were also cited by the respondents. Almost everyone described the scientist to be wearing a white lab coat and glasses. Many described the scientist as an intelligent person with either a neat, conservative outward appearance or a preoccupied, dishevelled outward appearance. These impressions were similar to responses of ninth and tenth graders in a study cited by Gardner et al. (1989). In fact, the drawing used in this article looks like numerous submissions that were made by the respondents of this study! There were no tallies kept due to the variation of responses, but a selection of quotes provided by students from each school have been included just to provide some of their feedback:

Bishop Ryan females:

> "Bright but seems lost in own thought. "
>
> "Thorough, precise, organized."
>
> "Close minded; whatever he says would be right and he couldn't care less if you understood what he said or not; would probably lose me in his double talk."
>
> "Patience to explain the work; enthusiastic."

"A normal person who when asked about certain aspects of science, can successfully explain and interpret scientific ideas and one who is very interested in developing or analyzing their environment and the things in them."

"Someone professional who would know at all times, what to do."

"Anyone who has done as little as simply dabbling with a theory."

Bishop Ryan males:

"Someone who needs all the facts; will not deal with 'maybe'."

"Dedicated to their work."

"Scientists may now know how to truly relax."

"Discuss world issues/pollution/greenhouse effect."

Cardinal Newman females:

"Would like women to become more active."

"Willing to share knowledge with others."

"Try to do what's right for people and environment."

Cathedral Girls' School females:

"Everything is interesting for them."

"Always trying to find new methods."

Cathedral Boys' School males:

"There is really no such thing as "typical scientists."

St. Jean de Brebeuf:

"Old due to time required for education and research."

"Distinguished and confident."

"Stressed as anyone would be who works to a maximum effort to find something they're looking for."

St. Mary's females:

"Always trying to prove others wrong and expecting others to be as smart as they are."

"Anyone who wants to be a scientist can be one."

"Intense and interesting."

"Lots of patience, devoted to job."

"Decisive."

"Look like they can handle a lot."

"In their own little world."

"They look they way TV portrays them: lab coat, glasses, nerdy."

"Frustrated and concerned."

St. Mary's males:

"All work no fun."

"His love for science dominates his need to be aesthetically pleasing."

"Keep to themselves; loners."

St. Thomas More females:

"Wrinkled brow from thinking too much."

"Not attractive but determined-looking."

"Have a love for science."

St. Thomas More males:

"Problems with his health, out-of-shape."

"Fiddling in chemicals trying to solve mysteries of universe."

iv) Summary of the Chapter

The analysis of the questionnaire responses revealed certain factors to be significant with respect to gender. Beginning with the demographics, the population was made up a larger proportion of younger, intermediate level students, falling between the ages of 14 and 16 years. This was true for both the males and the females, with a slightly larger percentage of females. It must be considered that age would have some effect on the responses provided in following sections. Due to the age, the sample was comprised of a much larger proportion of students in intermediate grades (9 and 10) with the females again making up the larger group overall. The respondents were very specific about their choices for the most important family member. A large percentage believed every member of the family to be of equal importance. By the same token, more female respondents considered their mothers as most important and more important. Brothers and sisters were given equal importance but to no great significance. Just the same, the emphasis was placed on the siblings of the same sex as the respondent. The respondents again showed preference for their own gender by identifying the sex of their favourite teacher. Overall, the males preferred male teachers and the females preferred female teachers.

The students also supported the traditional gender divisions with respect to preferred disciplines of science. Females chose mainly Biology and Chemistry. Males chose Chemistry and Physics. This was supported by the course enrolments for 1986, 1987 and 1988.

In terms of the future, the students had very serious career aspirations, the majority aspiring to very professional careers requiring substantial schooling. Also related were the impressions about the importance of marriage. The majority of the males wished to marry in the age ranges of 21-25 and 26-30 years, favouring the latter. The females fell into the same two categories, with even a larger proportion favouring the 21-25 year range. They both expressed strong support for the importance of marriage but there was a significant difference between the overall responses of the males and the females. The males gave marriage much more importance than did the females.

The ethnicities revealed the population to be primarily Italian in make-up with several other groups also being represented, to a much lesser degree. Although chi-square statistics were not available for this factor, it did turn out to be a revealing one about the background of the group. Certainly, any familial influence contributing to the large representation of this ethnic group cannot be ignored.

In terms of occupations of parents, two main categories were prevalent: "unskilled worker" and "other professional." The prevalence of parents in the unskilled worker group is most likely a socioeconomic representation due to the large industrial economic base of the city in question, as well as a representation of the ethnic background profiles. Similarly, the professional group is represented. Both can be considered to play a significant role in the academic and career decision-making processes, direction of their children, helping them to appreciate their educations and understand the importance of it.

The respondents revealed their favourite subjects to be science and math. Their choice of favourite teacher mirrored this. They identified ten characteristics of favourite teachers, the most highly ranked being teaching abilities and techniques. The teachers were described using at least some of the ten characteristics by all of the students.

The next part of the questionnaire measured science anxiety as generated by science and science-related experiences. The areas examine were testing, direct and general application of principles and performance in front of others. The greatest source of anxiety stemmed from the testing situation, indicating some need for altering the type of tests or the nature of the tests or even the frequency. The students also experienced a measure of science anxiety when performing skills or speaking in front of others more so than they did when applying principles in class or experiments. They did not relate anxiety to doing projects or performing experiments, suggesting these to be positive learning experiences.

The section called "Science Ability and Attitudes" was designed to measure motivation based on grades, performance of science activities outside of science class, feelings generated during science classes, and the classroom environment. In terms of grades, overall subject and science, the sample was achieving grades in the 70-100 range, with more females achieving these grades than males. The students were not motivated by reading or listening to lectures about science. They were motivated by watching TV science programs. A very positive factor to motivation was the response to feelings experienced by students during science classes. The students did not feel uncomfortable, stupid or unhappy and admitted feeling curious, confident and successful at least sometimes. In the classroom, they were mostly at ease during tests and labs, looked forward to attending science class and generally enjoyed projects.

Attitudes about women in science, the usefulness of science, participation in science and teacher influence were collected in the fourth section of the questionnaire. The females were extremely strong in their expressions in support of the presence of women in science and women receiving equal opportunities in science. The males were supportive, in that the pro-male statements were rebuked, and the pro-female statements were supported, but certainly were not as adamant in their responses as the females. All of the groups were positive about the usefulness of science to the future. Their participation hinged on classes being interesting and fun yet challenging. They did admit willingness to participate in question and answer situations especially when teachers encouraged expression of opinions and took a personal interest in the success of the students. These characteristics of teacher influence were important to the respondents and affected their overall participation.

In the final section, the students evaluated the importance of science skills. With the exception of reading with understanding, the males and females gave importance to all of the skills, giving the most significant response to evaluation, judgment of worth of facts, tests, conclusions of scientific data.

From the findings in this chapter, the variables acting as motivating or non-motivating factors can be identified and discussed. The implications of these factors will be considered with ideas suggesting modification, where necessary, and augmentation where possible. This discussion will take place in the following final chapter.

CHAPTER FIVE: SUMMARY, CONCLUSIONS, IMPLICATIONS

Summary

The study presented in this paper was initially inspired by the female students enrolled in science courses at the secondary school level. Its original intent was to determine the extent to which female students were continuing science studies. As the idea developed, it became the intention of the study to investigate and identify factors and/or variables which may contribute to the motivation behind continuous science study.

The background to the problem focused on the battle of women to overcome traditional stereotypes and long-perceived characteristics, especially in the field of science. Science has long been dominated by males and females' contributions were often ignored or taken for granted. This contributed significantly to the determination of women to reach new heights in the field of science by means of the establishment and attainment of new goals and the inherent recognition of their abilities. This has also been evident by the increased number of women participating in the workforce and to the economic picture of the family unit.

The study involved the development of a problem which involved, in turn, the identification of those variables thought to contribute to motivation for science study. It was developed in order to allow an examination of a representative sample group of students, enrolled in science courses, by means of a questionnaire. The instrument and the related findings comparing responses of males and females served to aid in the identification of the factors which affected female students specifically, so that greater attention to females could be addressed. The females could be an important key to the future of professional science and science-related areas if they are encouraged to study science, if they are made to see its importance, if they are made more aware of their abilities and skills, and if they are invited to consider the role they can have in the future of science.

Conclusions

In consideration of the extensive discussion of the findings, there is some advantage to again presenting the statement of the problem and the questions to be answered.

The statement of the problem was generated by the concern of the absence of females in the future of professional science and related areas if the present rate of enrolment of girls in science is to continue. The basis of the problem was the importance of knowing the exact standing of girls in science courses before the pursuit of interventions to generate change. By investigating the motivational factors influencing the decision-making process behind science study for females, those areas requiring greater attention could be identified. With this information, female students could then be encouraged to study science by being made more aware of the importance of such studies and the associated skills, as well as the effects of this on their future careers.

The purpose of the study was to examine a Roman Catholic secondary school (HWRCSSB) population in a southern Ontario school district (Hamilton) to gather statistical information about those males and females studying science at the advanced level. The information was analyzed to determine the existence of any motivational differences between the males and the females, as well as any reasons accounting for the differences. Underlying this were the questions:

(i) Who is continuing to enrol in science?

(ii) Who is not continuing to enrol in science?

(iii) Why?

In addition to the main questions, several objectives were considered:

a) to examine data on file at the Ministry of Education reflecting enrolment of males and females in advanced level science classes;

b) to develop an instrument which will examine a number of research variables such as demographic data, socioeconomic background, achievement, attitudes, motivation, teacher as instructor, classroom environment, academic aspirations, occupational aspirations and commitment, marriage and family aspirations, science anxiety, perceptions of women in science, importance of science skills, image of scientists, and the extent to which they motivate or influence students;

c) to determine if differences do exist between males' and females' enrolment patterns based on the responses to the questionnaire developed around the variables in (b);

d) to identify any specific needs of female students in science programs which may or may not be present in existing curricula (such as required skills, knowledge, methodology, role models, guidance and career counselling);

e) to suggest and outline existing programs to assist and encourage students, especially females, to continue to study science.

The discussion to follow will use the findings as they relate to the variables on the questionnaire and the objectives of the study. Where possible, generalizations will be made and conclusions will be drawn. The emphasis will be on those questions which generated responses which differed significantly when male responses and female responses were compared. The discussion will follow the same order that the variables take in the large sample questionnaire. (See Appendix C).

The first variable to be considered is demographics. A number of factors were included in the demographics in order to obtain a complete picture of the socioeconomic backgrounds of the students. The sample (N=1,345) was comprised of a larger proportion of females than males. This was advantageous because it provided a wider range of female responses, for which the information was extremely pertinent to this particular study. A larger proportion of the male and female respondents were between the ages of 14 and 16 years. This is significant because it provides evidence of a decrease in science enrolment in the senior grades, once the minimum requirement of two science courses has been completed. In fact, a comparison of the males and females over 16 in the senior level science courses revealed about 4% more males. The respondents indicated their preferences for the various science disciplines. The females expressed preference for Biology and Chemistry while the males expressed preference for Physics and Chemistry. This supports the enrolment data that were available for 1986-1988, which also reflect similar conclusions made by Hansen and Neujahr (1974) and Bowyer

(1988).

Which of the demographic factors, if any, contributed to these enrolment patterns? First, it might be useful to examine the influence of the family. The respondents indicated largely that all of the members of their family were equally important. However, there was some significance to the fact that beyond the family importance as a whole, the mothers were identified as having more importance than any of the other individual members.

The socioeconomic backgrounds of the respondents were obtained by means of questions about ethnic background and occupations of both parents. The population studied reflected a large number of different ethnicities, with the most highly represented being Italian in background. From this, it could be concluded that the parents of the student population were immigrants to Canada, or possibly children of immigrants. The occupations of the parents reflected the industry-based economics of the area being studied and the professional fraction of the local economy. There was a much larger proportion of parents in the "unskilled worker" category, which included factory workers, labourers, drivers, waiters/waitresses and homemakers, as opposed to a smaller proportion in the category of "other professional" which included executives, doctors, lawyers, etc. Parsons et al. (1982) suggested that parents influence their children by their actions, and their beliefs and expectations about their children's success. The nature of the parent occupations would reflect a very hard-working, economically stable group. Certainly, the fact that such a large proportion were working in factory or industrial settings would indicate the difficult nature of the work. This would then be related to the expectations imparted to their children of obtaining an education that would lead to an occupation less physically demanding and more financially rewarding. Ultimately, parents want to see their children financially stable and want for their children all that may not have been available for them.

With respect to the ethnic backgrounds, one conclusion that can be drawn might be that these parents feel that the Catholic schools provide a setting similar to that established in the home. The Church plays a significant role in the lives of many of the ethnic groups represented. By sending their children to the Catholic high schools, it might be concluded that the parents hope that the same morals, values and expectations demonstrated in the home and set out by the Church will be communicated by the schools.

Some of the traditional family beliefs were reflected in the responses to the questions about the importance of marriage and family. The students all had high aspirations about marriage, hoping to marry within the age ranges of 21-25 and 26-30. There was a significant gender response to this question. The females had hoped to marry in their early twenties while the males were evenly divided between the two age ranges. The males did consider marriage to be more important overall than did the females. This might be a reflection of the high occupational aspirations of the group as a whole. The females showed a somewhat higher tendency toward professional occupations than the males, who also aspired to professional occupations. One might conclude that these students are aware of the sacrifices and hard work of their parents and understand the value of their education. It also is a positive reflection of their beliefs that they place so much importance, as well, on the institute of marriage. It does seem, however, that the males might be more aware of the time required to achieve professional status in terms of occupation as reflected by their aspiration to marry at a later age.

The students were also very positive about the desire to have a family, both stating the importance of having children. Interesting, too, was the number of children desired. The males aspired to a two-child family to a greater extent than the females. The females did express a somewhat greater desire for a larger family, however. Again, the conclusion can be made that the females were taking their future career into consideration when providing a response to this question by indicating their desire for a family to a lesser degree than the males.

One other factor proved significant in the demographics -

identification of favourite teacher. The preference for the males was for male teachers and for the females the preference was for female teachers. This is indicative of the role modelling of the same-sex teachers and possibly of the classroom environment set by these teachers, as cited by Lawrenz and Welch (1983). Although students' perceptions of the classroom environments of these teachers were not assessed, the inference can still be drawn. Further to this, upon identification all of the characteristics of their favourite teachers, the students listed ten commonalities. These included, in order of preference,

- teaching ability/technique
- sense of humour
- friendly; easy to talk to
- makes class interesting
- can relate to students
- helpful and caring
- motivator
- intelligent; knowledgeable
- patient; understanding
- fairness.

These characteristics were influential to the students due to the frequency at which they were used. Characteristics of teachers who exert positive influence were also stated by

Kahle (1983). Some included professionalism, knowledgeability (with respect to career information and relating science to everyday life), fair treatment and fair expectations, unique teaching behaviours, among others. The influence of teachers is certainly a motivating factor to science course enrolment and most likely to overall course enrolment, judging by the range of characteristics identified by the respondents.

The next variable taken into consideration was science anxiety as it related to science and science-related experiences. Areas that were examined for anxiety included testing, direct application of principles, and performance in front of others. The greatest degree of anxiety was associated with testing. For the respondents, the females were much more anxious about testing situations compared to the males, regardless of the magnitude of the test. The females were even anxious about preparing for a test and thinking about a test in science. Continued anxiety on the part of the females would have a negative impact on their continued enrolment in science courses and on science career interest. This was supported by Matyas (1984). Thus, it is necessary to make certain changes in the nature of testing situations to address the anxiety felt by female students.

One other area that was a significant source of anxiety involved participation in the classroom. Explaining a topic, being called on in class, being observed while doing an experiment, and explaining a chapter of a science text were all anxiety-causing situations. Again, the females associated more nervousness with these situations than the males. It is important for the science teachers to examine the associated behaviours to these oral participation situations in order to better identify the negativity. Once this has been done, steps can be taken to improve the environment to make this type of participation less imposing and less intimidating to the female students.

In terms of positive motivating situations, the students showed a definite lack of anxiety towards doing science projects and following directions to experiments. These activities were preferred, probably due to the fact that little oral participation is usually involved. These two activities may be ones that can be utilized to improve willingness to participate orally perhaps by requesting one-to-one explanations, small group presentations and building to class presentations. It is also important for students to receive positive reinforcement and feedback to their participation as an additional method of helping to overcome the associated anxiety. Overall, the students did not relate anxiety to the direct and general application of principles. They were calm about most of the skills with the exceptions of focusing a microscope and lighting a Bunsen burner. It is reasonable to state that these two skills require a certain amount of practice and experience before students become accustomed to performing them well. Therefore, until they have mastered their use, some anxiety will be experienced.

Only two questions addressed ability and these simply focused on grades obtained overall in high school and in science. The students were found to be in the top grade ranges (70-100%) which was expected due to their enrolment in advanced level science courses. The females did show a slightly higher grade range in science, nonetheless. Within the same section, motivation was measured by means of attaining a perspective of the students' attitudes toward science. It was interesting to note that the students, both male and female, rarely performed science or science-related activities when not required to do so for science class. These included reading newspaper and magazine articles, watching TV programs, attending lectures, reading books, and doing projects or hobbies related to science. These activities could be more meaningful and motivating if their value were highlighted more in non-science areas of learning. If more efforts were made across the curriculum to incorporation these science-related activities, the students might gain some degree of motivation from them and become more apt to perform them out of sheer interest rather than just necessity.

Students often associate certain feelings with science classes. There were six feelings used as a measure of motivation, divided into positive (curious, confident, successful) and negative (uncomfortable, stupid, unhappy). The outcome revealed that in science classes, male and female students generally felt comfortable and challenged, judging by their responses to the negative feelings. The two of significance were feelings related to confidence and successfulness, with the respondents indicating that these were only sometimes experienced in science class. With females already feeling a greater degree of anxiety, it is detrimental to them to also rarely experience feelings of confidence and success. Measures must be taken by teachers of science to create more opportunities for successful learning experiences. Feelings of success are often associated with those of greater confidence; therefore, if motivation is to be heightened, an increase in the number of confidence-building experiences is necessary. This was supported by Matyas (1984) and Levin and Fowler (1984).

A measure of motivation also involved the classroom environment. The only area that caused a certain uneasiness involved that of the testing situation, where the females expressed greater feelings of nervousness than the males. It has already been established that test anxiety is an important factor, so it was logical for this particular aspect of the classroom environment to be identified. It was advantageous to learn that within the science classroom environment, students looked forward to attending class, enjoyed labs and projects. The "undecided" option served as a way of avoiding making response commitments, as many chose this option for questions which may have been more revealing of their true feelings. Nevertheless, classroom environment ended up being more motivating than not.

To summarize, the areas where improvements or changes are necessary, discussed so far, involve testing, oral participation, performance of science-related activities, and motivation related to building successful experience and confidence.

Probably most revealing of all were the responses and attitudes about women in science. The findings revealed female students to be extremely positive about the role of females in science. In every situation but two, the females expressed the extremes of the response options available to make their points - that females have the same abilities, can make significant contributions, and gain the same benefits from their involvement in the fields of science. These results were similar to those of the study conducted by Welch, Rakow, and Harris (1984). These researchers also found that females expressed significantly more positive attitudes toward females in science than the males. The findings of the study being discussed by this paper contradicted, however, the findings of Taylor and Mardle (1986). The males were mostly supportive of the roles and contributions of females in science while in the Taylor and Mardle study, the males showed a greater tendency to believe that females should remain in the home and that the education of males is more important than that of females.

Also contradicted is the statement by Russell (1979) that stated young female students limit their own achievement in order to attract males. The female respondents to the study conducted for this paper certainly did not reveal the belief that males will determine the future or the success of females in science. This can be attributed to a greater awareness of the realm of opportunities in science on the part of females, as well as less traditional sex-stereotyped thinking on the part of the females. Even at a younger age, female students understand the need to take a stand against traditionally male-dominant thought.

The study also determined perceptions of the usefulness of science. Once more, the population studied was very supportive and open-minded about the usefulness of science to everyday life. As a teacher of science, this researcher often stresses the benefits of learning the scientific method of problem-solving and the associated thinking skills. Certainly, if they do not remember the content, they will still have the means to solve problems and locate information as it is needed. Hence, the value of science is recognized and might be multiplied by science enrolment throughout high school.

Science classes were perceived as being boring somewhat more often than being perceived as interesting and fun. The curriculum does not always allow lessons to be full of excitement, but, by the same token, students taking science in this day and age have become used to being bombarded with colour, flash, and noise. The media has contributed significantly to this with the trend to video presentations and computerization. As technology becomes more sophisticated, it makes the job of the classroom teacher that much more demanding. How does a teacher compete with a flashy video presentation? At one school, senior physics students are combining their science and computer skills to complete the independent study components of the courses. The students are preparing learning modules on various topics in science, in this case physics, that serve as learning tools for other students. This is one way in which the skills of science and technology are utilized to make the science class more interesting and appealing. In addition, it helps to highlight the relationship between science, technology, and society. For the most part, the students expressed enjoyment of science due to the degree of comfort felt, but they also did admit to feeling challenged in science class.

Teacher influence was discussed in the literature by numerous researchers (Ricks and Pyke, 1973; Welch and Lawrenz 1982, 1983; Kahle, 1983; Aiello-Nicosia et al., 1984; and Yergeau, 1988). All of the researchers, while conducting different studies, recognized the extent of influence that could be attributed to the teacher. It was suggested that teachers required a working knowledge of the curriculum and should be able to demonstrate the importance of science to careers.

The students who participated in this study supported the ideas of the previously mentioned researchers in the identification of the characteristics of teachers they most preferred. They also offered insight to the extent to which their science teachers influenced them as individuals. Students placed emphasis on being recognized as having opinions and subsequently, being encouraged to express them. They felt that their teachers were permitting the expression of opinions. They did point out that their teachers rarely admitted to not knowing the answer to a question and they found this aspect to be somewhat disturbing. One reason for the reluctance to admit to a lack of knowledge might be attributed to the science background of the teachers, required to obtain a bachelor of science degree, at least. Also, many science teachers have been teaching science courses for a long time and experience often provides the answers to questions that are generated by students. Despite this, to admit not knowing an answer might make the teacher appear more human, and less infallible, to the students. On numerous occasions, learning together with students creates a more positive atmosphere in the classroom and mistakes can generate discussions of possible answers using curriculum content.

Lastly, students provided their perceptions about the importance of science skills. The emphasis on the worthiness of the skills to the individuals was made and the students responded most positively. Briefly, the skills involved reading with understanding, interpretation of data for meaning, accurate measurement and observation, use of the scientific method for problem-solving, classification, and evaluation of facts, tests, and conclusions of data for worthiness. All of the skills were deemed important for the individual to learn. The female students did place somewhat more emphasis on reading with understanding, use of the scientific method, and evaluation of scientific data. Thus, it appears that the respondents had some appreciation for the benefits of the skills they could acquire from enrolment in science courses. Despite admitting to gaining little satisfaction from reading scientific material for the sake of interest, they were aware of the necessity of literacy with comprehension. It is likely that students do not always realize that these skills are acquired from science study even though they are practised frequently. Keeping the students aware of the advantages of mastering these skills will definitely contribute to their success in science and, ultimately, to their confidence.

In closing, a reiteration of the significant variables that did not act as motivating factors is useful. Anxiety was associated with testing and oral participation in science class. Little motivation was derived from the performance of science and science-related activities when not required for science class. Doing experiments and projects did generate motivation and there was some preference for this type of work over that involving reading. The classroom environment provided some degree of motivation overall, with attention required to alter the environment during situations involving tests. The attitudes toward women in science were very positive and present one area where motivation might be further generated by taking advantage of the perspectives and playing on the importance of the roles of women in the future of science. Greater motivation could be derived by improving the participation of students in science classes so that their impressions that such classes mean boredom can be changed to impressions reflective of creativity and interest. Lastly, the extent of motivation generated by the influence of the teacher can be augmented by improving teaching techniques and incorporating more into the courses about skills and career opportunities. Methods that address these areas, with an emphasis on the attraction of more female students, will be considered in the section that follows. It will involve the inherent implications of the findings.

Implications for Practice

A) Approaches to Encourage Females to Science Education - Literature

What can be done to change the participation of females in science? The literature already presented offers numerous suggestions and strategies pertinent to the outcome. Since these have already been discussed, it is now time to briefly examine literature which has been devoted strictly to the presentation of approaches that will encourage females to science education. The literature will be considered chronologically to show the development and proliferation of it in more recent years.

Smith (1974) provided four strategies directed to the modification and alteration of educators' practices which perpetuate sex-stereotyped roles. Such practices include the formal and informal tracking of males and females into particular courses, different behavioural expectations, and use of sex-biased curriculum materials. These do little to alter the model of the future and it was recommended that women should be portrayed in a variety of science career roles in order to begin to correct the old notions. He also offers suggestions for the positive encouragement of females into normally "avoided" areas and methods to overcome barriers.

Button and Brown (1980) supported the use of programs that provide role models and information about achieved women scientists, past and present. They also supported the idea of the integration of women into the science curriculum, in order for girls to achieve their full emotional and intellectual potential. They suggest the recognition of Women's Day through minibiographies and speakers, use of non-sexist literature to expose students to non-traditional roles and careers.

In "Who Turns the Wheel" proceedings of a workshop on the science education of women in Canada, Erickson proposes that most programs which encourage females to science have been developed in the United States. She referred to three categories of activities:

a) career workshops and materials for students;

b) workshops for science teachers and career counsellors;

c) curriculum projects or classes for girls in content areas.

The career programs are designed to encourage female interest in science-based occupations by reaching students from elementary school to those in college. The counselling workshops were described as taking on a more personal approach, involving more interaction and attention to individual differences. These workshops also permit the encouragement of females by parents, teachers, and counsellors. The idea of changing the male image of science could be fostered by making course contents and materials more relevant and interesting to girls, through the development of programs to upgrade girls' informal knowledge of science, as well as the formal.

Further suggestions focused on the role of the teacher. In-service programs focusing on the examination of expectations for males and females in science and the development of awareness of sociocultural factors which contribute the to the underachievement of female students. Issues to be examined included classroom management, student-teacher interactions, and science subject material presentation (Science Council of Canada, 1982).

Also suggested are inservice programs for career counsellors in order to help them examine their own expectations for occupations of males and females, understand contributing factors to limited female career perspectives and to consider methods to promote the interest of girls in non-traditional science-related careers.

Additional research from the Science Council of Canada resulted in <u>Summary of Report 36: Science for Every Student - Educating Canadians for Tomorrow's World</u> (1984) which presents several concise suggestions for the renewal of science education so as to better meet the needs of today's students. In the area of science education for all, three initiatives are proposed:

i) guaranteeing science education in every elementary school with science training for teachers, support, and provision of adequate supplies, facilities, and appropriate curriculum materials;

ii) increasing the participation of young women in science education to ensure that girls have improved opportunities and encouragement to full participation by means of pre-school experiences, appropriate classroom practices, emphasis on the science-technology-society interaction, use of female scientists and inventors as role models, and increasing awareness of career opportunities;

iii) challenging high achievers and science enthusiasts using enrichment programs. (Science Council of Canada, 1984)

The recommendations of the Science Council of Canada sparked the beginning of the development of numerous programs sponsored by universities, museums and community groups. To meet the challenges, Ministries of Education, school boards, schools, and teachers took up the cause of bringing Canada up to par, science-wise, with the United States. Among these interested groups was the Canadian Teachers' Federation. The CTF began a compilation of descriptions of available projects and programs in 1987-1988. The result of the compilation was The IDEA Book: A Resource for Improving the Participation and Success of Female Students in Math, Science, and Technology. The manual begins with a recap of the problems related to science education and participation of female students in science. It discusses career expectations of female students, the experiences of females with respect to sex differences and self-concept, and offers guidelines for educators towards the encouragement of females and the development of innovations to promote this idea. The balance of the document is devoted to the presentation of programs being used to promote female participation in math, science, and technology. Some of the names listed as contacts for programs devoted to promoting science were used by this researcher in order to obtain information about existing programs. It should be noted that, in some cases, programs described were pilot projects or proposals which were never approved or developed. Nevertheless, this book presents a valuable resource for anyone considering the phenomenal task of changing science education for females. It would also be of some advantage to have a more recent listing of programs provided periodically to determine if these types of interventions are actually increasing in demand and success.

A similar document was developed in 1983 by York University. The handbook, Strategies: Intervention Techniques to Keep Women in Mathematics and Science Studies stemmed from the W.I.S.H (Women in Science, Hopefully) committee and was designed to develop intervention strategies for female students in Grades Nine or Ten. It describes four basic intervention strategies, related to science, which began to be implemented in 1984. These were Careerscope, Science Odyssey, the Apprenticeship Program, and a fourth program involving Physics (Strategies,1988).

Strategies also presents brief descriptions of U.S. programs which are also listed here without descriptions:

i) COMETS (Career Oriented Modules to Explore Topics in Science);
ii) EQUALS, SEQUELS, and FAMILY MATH;
iii) TEAMS (Training for Equitable Attributes in Mathematics and Sciences);
iv) MATH/SCIENCE NETWORK.

Ulmanis (1986) describes taking advantage of science museums to attract women. Described is Women in Science and Engineering produced in Chicago by the Museum of Science and Engineering. It is accompanied by lecture series, workshops, field trips, and teacher curriculum materials, and examines related social and historical issues of women in science. She goes on to suggest the value of a science centre designed at women to raise consciousness about their aptitude for science and technology, their intellectual suitability for careers in those fields and the social problems that surround such a choice. In other words, it would make science relevant to women.

In Apprenticeship: A New View of the Future - Counsellor's Handbook, produced by the Ministry of Skills Development (1989), several suggestions for the attraction of females to skilled occupations are offered. The basic premise is that the more teenage women believe themselves to be capable of performing non-traditional occupations, the more interesting it is to them. Success in science, math, and manual arts enhance the attractiveness of such occupations.

Zalnieriunas (1989) wrote about "Science and Math for Girls" referring to the CTF's IDEA book and its contributors. Evidence to support the lower representation of females in Ontario high school physics courses and in many other science and math courses is offered. She cites the equal abilities of girls and boys in science, the influence of teachers causing boys to be assertive and interactive and girls to be passive observers, and the steady advancement of female enrolment in science and math at the post-secondary level.

To overcome some of the difficulties, role models are proposed to reflect the rewarding career and family that is possible with a science or science-related career. Also discussed is the benefits of the Waterloo County Separate School Board's Co-operative Education Program in Science and Technology. It is run by two female advisors, Mary Beam and Jan Varner, who run workshops for teachers and for students in Grade Ten. They aim to dispel the Cinderella myth that a man will eventually rescue them from the workplace drudgery. Their approach is to bombard students with statistics, questions, barriers related to non-traditional careers in order to heighten the awareness of the participants.

Gardner, Mason, and Matyas (1989) emphasized the need for more young women to participate in science studies for the purpose of promoting educational equity and equal career opportunities and to contribute to future economic and research competitiveness. The article provides some positive motivating factors that promote continued science study.

The balance of the article is devoted to suggesting strategies to overcome the negatives and augment the positive. They begin by pointing out that curricula which encourages female students, also proves beneficial to males, and minorities of both sexes. In the selection of strategies, teachers of science are encouraged to "check your attitude" for subtle biases that can effect teaching behaviours. Teachers are urged to take a hands-on approach to address different interests and past experiences of male and female students.

Teachers are directed to "think small" which means to spend less time on lectures and whole class discussions and increase the opportunities for small group work. This tactic would permit more active involvement in the learning process and the teaching process. The authors suggest that small group work be structured so that discussions focus on problem-solving to show the probability of many solutions and the practicality of several approaches to reach them. They recommend that each member assume the leadership role and all students manipulate equipment. The end of the small group assignment should be a class discussion synthesizing the group responses because this is less inhibiting to participation on an individual basis (Gardner et al., 1989).

The strategies suggested are in line with the variables deemed to be in need of attention in the study being discussed here. They appear to be the easiest to implement and involve students to the greatest degree. They are positive, potentially motivating, and make science students aware of the presence of stereotyped behaviours to which they are exposed in school. Their increased awareness might be motivating in itself. The strategies mentioned are also very similar to the sex-equity strategies alluded to in Chapter One of this thesis (see Definition of Terms), and suggested in the curriculum guidelines for science at the intermediate and senior levels by the Ministry of Education (1987). These guidelines form the basis for all board teaching programs and it would seem to make more sense to present them at the beginning of the document outlining policy and programs. In this manner, the inclusion of the strategies would be more inherent to the science teaching program offered in the schools.

B) Approaches to Encourage Females to Science Education - Programs

While the literature discussed provided some information about strategies for teachers and programs available to female science students, there are numerous programs, lectures, workshops, training sessions, etc., which have been designed to address the issue on a more local level. The time frame for the study described in this thesis allowed the amalgamation of materials used in such programs, or describing such programs. The purpose of this section is to provide an overview of some of the more pertinent strategies. It is important to note that the descriptions that follow are examples of only a few of the programs. With the vast number now becoming more readily available, it would involve another completely new study in itself to amalgamate, examine, describe, and evaluate all of the available strategies.

The Ontario Women's Directorate offers programs for female students under the headings of "Pathmakers" and "Open Doors." These programs rely on role-modelling to broaden the awareness of students of their career options by connecting them with women who work in the various science and science-related fields.

The students at the secondary level are, in fact, gaining awareness about job opportunities in the Hamilton area through programs like "Partners in Education." This program pairs each of the high schools in the separate school board, with institutions or facilities of employment. For example, St. Jean de Brebeuf is paired with St. Joseph's Hospital. The pairing permits a two-fold objective experience. It allows the students to contribute their skills and abilities to the hospital by means of volunteer work, designing and creating floats for parades, and representing the future of the hospital at various charity and benefit functions. The hospital meets its part of the objective by allowing students to tour the facility, providing information for projects and assignments, and holding career day activities, whereby role models and students can exchange information.

Similar sessions are now becoming more frequent at the high schools, which involve some of the local post-secondary institutions like Mohawk College and McMaster University. These career fairs and information sessions introduce high school students to teachers of post-secondary programs and to students enrolled in such programs. This not only provides high school students with course information, but also permits some very valuable communication with people directly involved in the learning process. Further to this, university professors are usually recruited by the local school boards to serve as judges of science fairs, which display the capabilities of students of all ages, in all areas of science. The professors are often enlightened and sometimes surprised, by the different perspectives presented by the students. The students also gain experience in discussing their experiments with experts in the fields. Once again, there is a double goal that is met.

Students are being invited to attend workshops and information sessions at the local university, in the areas of science and engineering. The secondary students spend time at the university in order to gain some insight into the workings and goings-on of science labs, for example. Certainly, students who have made frequent visits to a university campus will eventually become more comfortable with the learning environment. Another avenue which provides high school students with information about studying science at the university level is the return of former students to talk to the class about their experiences. All of these kinds of experiences serve as important sources of information that young high school students can utilize when making crucial career decisions.

A participant's guide to a workshop conducted in Quebec provided another valuable source of information. The guide was created for a workshop entitled "Girls in Non-traditional Programs" conducted by the Bureau de la Coordination de la condition feminine Ministere de l'Education du Quebec in February, 1988. The objective of the workshop was to allow participants a better understanding of the situation facing women in the workplace and girls in non-traditional programs (Yergeau, 1988).

With respect to actions that can be taken by individuals to generate interest in non-traditional careers for girls, the following can be done. Individuals can

-become more aware of the importance of individual attitudes and practices;

-examine the impact of these attitudes and practices on girls;

-observe, review, and become better equipped to improve attitudes and practices;

-organize incentive activities for girls.

As a school system, plans of action might include:

-the organization of in-service sessions for staffs;

-the selection of target objectives and activities which correspond to assessed needs;

-an examination of the myths and realities of the job market;

-offering career awareness activities which focus on non-traditional careers for females;

-the establishment of welcoming services for girls in registered in non-traditional classes;

-the set-up and placement and follow-up services for girls who have graduated from non-traditional programs;

-an evaluation of the effectiveness of programs in terms of interest generated in non-traditional careers for women. (Yergeau, 1988, p. 133)

WISEST stands for Women in Scholarship, Engineering, Science and Technology, a student summer research program associated with the University of Alberta. The program is aimed at female students in Grade 11 who spend six weeks during the summer in research groups in the Faculties of Science and Engineering. The purpose of the program is to develop interest in science careers and engineering careers, and provide information pertinent to success in their chosen field (Armour, 1987).

In Sudbury, the Women Teachers' Association in conjunction with Cambrian College and the Sudbury Board of Education, offer a series of career workshops for Grade Seven girls called "Girls Grow Up - An Alternative Careers Workshop." The workshop was designed to encourage Grade Seven girls to recognize the importance of the maintenance of their maths and sciences and to heighten their awareness of non-traditional careers available to them.

Numerous similar workshops were identified across the province. Since little information was provided by the contacts, these will be listed and only briefly described.

1. Spotlight on Girls in Science and Technology
   -offered through the York Region Board of Education

-aimed at students in Grades Seven and Eight

-offered to increase awareness of science and technology fields, to promote subject and career choices in these fields, to provide opportunity for interaction with girls with similar interests, and to allow the sharing of the experiences with peers in home schools

-also involves teachers to increase awareness, observe and develop strategies

-emphasis on "hands-on."

2. Celebration for Grade 11 - OAC Senior Girls in Science

-offered through York Region Board of Education

-two keynote speakers and workshops.

3. Reach for the Stars

-sponsored by the Carlton Board of Education and the National Museum of Science and Technology

-designed to encourage young women in Grades Seven, Eight, and Nine to consider career paths related to mathematics, science, computer studies, and technology.

-encourages females to maintain studies in these areas beyond compulsory courses to have a wider range of career choices available to them

-emphasis on "hands-on", role models, and mentors
-teachers are also invited to heighten awareness.

4. Scientifically Yours
-sponsored by Brock University
-aimed at females in Grades 11 and 12 interested in science and mathematics
-three-day event including career and gender stereotyping seminars, project workshops from areas of biology, chemistry, physics, computer science, mathematics, geology, and psychology
-also includes field trips, leisure activities, meals and accommodations for the participants

Thus presented is a summary, albeit brief, of some of the more local programs.

One final presentation of approaches that can be taken to encourage females to study science and math is addressed to parents. The ideas came from one of several leaflets of information made available to participants at the 1990 National Staff Development Council Conference. It was passed on by the science consultant of the Hamilton Separate School Board, who thought it might be useful. Unfortunately, the source listed was not complete, citing only Adults, 1990. Nevertheless, the suggestions are still worth examining, especially since the majority of the programs discussed are addressed to teachers and not necessarily to parents. The suggestions deal with the development of positive attitudes and expectations through setting goals, personal involvement in decision-making, support for decisions, involvement in extra-curricular science-related activities, among others.

C) The Future of Women In Science

The abundance of literature available on this subject reminds one that there is much more emphasis being placed on women in science, the associated issues and problems, and the strategies that can be utilized to overcome the problems. The question remains, what is the future of women in science?

In an article in the Hamilton Spectator (December, 1990), Johnston spoke with three female faculty members of McMaster University on the progress of women in the last 20 years. The three women did express a certain degree of greater awareness about both sexes, male and female. They felt attitudes have begun to change, but the process has been slow. Male students have become more accepting of female input and see them as equals, at least at the university level. But, the workplace and its related competition for the "good" jobs changes male attitudes, causing them to see females as threats. Ultimately, these educators attribute little advances to attitudinal change without respective changes in social structures of family, education, politics, and business.

An interesting aspect of the article was the inclusion of three tables that showed the changes in participation of women in universities and in the workplace. Compared to 1971, 1986 showed an overall increase in the percentage of women in professional careers (Johnston, 1990, p. A7).

In Women in the Workplace by the Ontario Women's Directorate (1984), it is stated that it has been proven that women work for the same reasons as men, that is, financial need and personal fulfilment; that most employers say that the sex of their supervisor or manager is irrelevant; that increasing numbers of women are combining a career with a family life; and many other similar statements regarding the role of women in the workplace. If all of these statements have been proven to be true, then it is clear that some changes must still be made before the practices match the advances made by women. This seems true for all areas, including the non-traditional careers involving science and technology.

If females are to succeed in science study and careers, they must make efforts to obtain accurate realistic information on a continuing basis, at an early an age as possible. Experience breeds success and, in turn, confidence, so the more science can be made to be an integral part of the life experiences of females, the greater will be the effect on decision-making with respect to course and career choices.

Implications for Further Research

The study to determine which motivational factors contribute to science course enrolment covered a wide scope of information and elicited a number of additional research questions. In the area of test anxiety, a study might be developed relative to science tests to identify the types of study skills and methods used by students to prepare for such tests. An examination of these skills might help to shed light on the weaker areas of preparation probably contributing to test anxiety in science. Such a study might also focus on impressions of preparation for and writing of different types of tests including quizzes, oral tests, and final examinations.

With respect to extra-curricular science and science-related activities, a project might be conducted in which a program to encourage participation in such activities is developed, conducted, and evaluated for a specific age group or grade level. Since participation in these types of programs generated confidence in participants, it would be of great value to create more opportunities to practice science and science-related activities.

It would certainly be worthwhile to prepare a study which focuses on the programs offered to encourage females to science study or to non-traditional areas of study, in a specific school board or geographical area. This might involve an accumulation of background information about these programs, participation in the programs and workshops themselves, personal interviews with coordinators and participants, a rating or evaluation of the programs, and identification of potential outcomes.

Teacher influence might be studied with a concentration on the ten characteristics identified by the students who participated in this study. The ten characteristics might form the basis of a student-based questionnaire dealing with science teachers, as well as a teacher-based response scale, in order to determine the extent to which those characteristics affect science students and classes.

A similar study to this one might be conducted using students enrolled in science at a different board, the public board, for example. This would permit some comparisons of the variables significant to those students attending public secondary schools. Similarities and differences might be highlighted, as could characteristics of teachers, favourite subjects, and importance of science learning and science skills. A repetition of this study might also be revealing if conducted using students enrolled in science courses at the general level. Many of these students do not take more than the two compulsory science courses at the secondary school level, so it might be useful to address some of their perspectives and impressions to better meet their needs in science classes.

Furthermore, to better gauge the trends in science enrolment, a study of enrolment in post-secondary institution science and science-related fields would be a logical and worthwhile follow-up to a secondary school-based study. It would provide evidence for the changes in participation of women in non-traditional areas and might offer support to the utilization of incentive programs and strategies to encourage females into continued science education.

If a study of the nature of the one conducted by this researcher were to be repeated, certain constraining limitations would be identified in order for the study to proceed more smoothly. First, the magnitude of such a study can be overwhelming. There is such a prolific amount of information available on the subject, that the study becomes an extensive presentation of the past, present, and future ideas found in the literature. A focus on one or two particular variables contributing to female participation in science might make such a study more manageable. Second, to administer the questionnaire, it would be more personal and beneficial for the researcher to present a brief overview to the groups participating. By doing this, the participants can be made aware of the nature and importance of the study, the expected outcomes, and the seriousness of the questionnaire and related responses. Their participation can be encouraged by allowing them to ask questions. While this might not eliminate the human factor behind some questionnaire responses, it would certainly decrease this aspect. Furthermore, personal administration of the instrument would ensure the efficient distribution, understanding of instructions, and subsequent collection of responses. It might even allow for the inclusion of personal interviews to expand on the impressions of the sample being studied. Third, the questionnaire items should all be completed using Scantron sheets. This facilitates the collection of pertinent statistics and subsequent analysis. The time factor in analyzing the sections that did not appear on the computer cards added several weeks to the study and required meticulous record-keeping. Fourth, the population estimates provided by science department heads must be accurate and precise to the timing of the questionnaire. Estimates which are too high increase costs (of Scantron sheets, paper, and photocopying) while estimates which are too low might result in a sample which is not representative of the students in the area being studied. Constant communication with contacts is a must, as is confirmation of details prior to embarking on subsequent steps. The fifth point involves the positive consequences of establishing relationships with individuals who can be helpful to you and the study. It was of great advantage to be able to work with colleagues proficient in the use of the computer, comfortable with giving up some of their own time to help, and understanding enough of the importance of doing this kind of research. Such contacts proved to be invaluable because of the moral support, physical help, insight and assistance to identify areas and ideas which may have been overlooked. The bottom line is to take advantage of all contacts, however minor, as their contributions are significant to the completion of such a study.

As for the findings of this study, it is hoped that the school board will appreciate an overview of the areas that require attention in the encouragement of females to science study. The motivating factors found to be significant to the population studied can be easily addressed. A follow-up to this paper might be the proposal to begin a series of programs to promote the usefulness of science to the everyday lives of students, the benefits of continuous science education to thought processes and problem-solving, and the opportunities for future careers available if science education is incorporated into the academic phase of students' lives.

In closing, the study proved to be an enlightening experience for this researcher. It was never expected that it would be of such magnitude. It forced an examination of teaching strategies and practices used in the science classroom and offered new insights and perspectives into science students and science teaching. This writer is now much calmer about meeting goals of curriculum to the point that it becomes detrimental to the students. More frequent practice of encouragement is used with students whenever possible and with their parents when the opportunity presents itself. It is exciting to see female students in science classes working diligently and willingly, experiencing success and confidence. Teaching science while completing this thesis has taught the value of taking time to establish relationships with students. There is great satisfaction to be obtained by the experience of watching former students pursue science careers, knowing that, as their science teacher, you had some influence in the decision to do so.

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APPENDIX A

Information Resources and Analysis,
Policy Analysis and Research Branch,
15th Floor, Mowat Block,
900 Bay Street,
Toronto, Ontario.

Mrs. Domenica Leone,
44 Oakridge Drive,
Stoney Creek, Ontario,
L8G 2T6

18 October 1989

Dear Domenica:

I have made some progress in investigating sources for your thesis data:

A. We have extracted the 1987, 1988, and 1989 course enrolment data for science courses in the schools you requested. The printout identifies courses by their three character common course code, year (1 to 5, with 0 being OAC), gender and level (Advanced, Fondamentale/Basic, General);

B. Information on the private school components of each of the seven schools is available by division (Senior, Honour) and by School for the years 1975-79, 1980-83 on microfiche. Course enrolment by gender is not available at that time. There is also enrolment data for the Intermediate science courses (Grades 9 and 10) for the publicly supported Roman Catholic secondary schools. I located one table (which was discontinued in the early 1980's due to cost) which presents a historic enrolment span and shows three years on one table;

C. Data on enrolment for 1984 is complicated by the partial introduction of the common course code. There are microfiche available but again, not by gender;

D. Data for 1985 and 1986 are also available on microfiche. I have not yet had the time to check on the availability of data by gender.

You may wish to consider coming into Toronto for a day and going through the microfiche. They are here and therefore more accessible than the hard-copy records in Cooksville archives. If the data on the microfiche are useful to you, it will minimize the amount of data we need to recall from the archives and thereby cut down on your expenditure of time.

Please give me a call when you receive this package and we can set up a time for you to come in.

Yours sincerely,

Anne Lloyd-Adams

(Dr.) Anne Lloyd-Adams, Statistician
(416) 965- 3157

NUMBER OF STUDENTS ENROLLED IN SCIENCE COURSES
FOR THE HAMILTON-WENTWORTH RCSSB

			LEV1 A		F/B		G	
SCH_NAME	CRSCD3	YEAR	MALE_STDNT	FEM_STDNT	MALE_STDNT	FEM_STDNT	MALE_STDNT	FEM_STDNT
BISHOP RYAN SEPARATE SCHOOL	SBH	3	50	77	.	.	.	.
	SBI	5	20	42	.	.	.	.
	SCH	0	39	30	.	.	.	.
		3	64	56	.	.	.	.
	SNC	1	92	90	27	8	29	22
		2	59	86	9	4	38	38
	SPH	4	25	9	.	.	.	.
		5	23	17	.	.	.	.
CARDINAL NEWMAN COMPREHENSIVE SCHOOL	SBI	3	32	80	.	.	.	.
		5	11	37	.	.	.	.
	SCA	3	.	.	.	.	27	14
	SCH	0	32	44	.	.	.	.
		3	82	78	.	.	.	.
	SNC	1	123	143	18	4	52	33
		2	113	126	8	2	50	47
	SPH	4	44	40	.	.	.	.
		5	34	16	.	.	.	.
CATHEDRAL BOYS SEPARATE SCHOOL	SBI	3	14	0	.	.	.	.
		5	10	0	.	.	.	.
	SCH	0	7	0	.	.	.	.
		3	20	0	.	.	12	0
	SNC	1	59	0	22	0	52	0
		2	47	0	21	0	45	0
	SPH	4	26	0	.	.	18	0
		5	9	0	.	.	.	.
CATHEDRAL GIRLS' SEPARATE SCHOOL	SBH	3	0	61	.	.	.	.
	SBI	5	0	40	.	.	.	.
	SCH	0	0	16	.	.	.	.
		3	0	26	.	.	0	20
	SNC	1	0	108	0	25	0	61
		2	0	71	0	9	0	46
	SPH	4	0	9	.	.	0	4
		5	0	5	.	.	.	.
ST MARY'S SEPARATE SCHOOL	SBI	3	43	48	.	.	5	11
		5	26	27	.	.	.	.
	SCH	0	23	19	.	.	.	.
		3	52	43	.	.	.	.
	SNC	1	89	88	10	6	27	24
		2	77	79	.	.	22	30
	SPH	4	15	15	.	.	.	.
		5	15	6	.	.	.	.
ST THOMAS MORE COMPREHENSIVE SEPARATE SC	SBI	3	45	89	.	.	10	16
		5	28	47	.	.	.	.
	SCH	0	29	23	.	.	.	.
		3	44	60	.	.	10	4
	SNC	1	70	115	7	2	25	17
		2	97	107	10	4	32	18

NUMBER OF STUDENTS ENROLLED IN SCIENCE COURSES
FOR THE HAMILTON-WENTWORTH RCSSB

			LEV1					
			A		F/B		G	
SCH_NAME	CRSCD3	YEAR	MALE_STDNT	FEM_STDNT	MALE_STDNT	FEM_STDNT	MALE_STDNT	FEM_STDNT
ST THOMAS MORE COMPREHENSIVE SEPARATE SC	SPH	4	31	25	.	.	17	4
		5	38	14	.	.	.	.
ST. JEAN DE BREBEUF HIGH SCHOOL	SBI	3	32	71	.	.	11	15
		4	1	0	.	.	.	.
		5	14	44	.	.	.	.
	SCH	0	22	35	.	.	.	.
		3	53	56	.	.	.	.
	SNC	1	105	122	13	6	68	45
		2	87	114	11	7	79	41
	SPH	4	9	13	.	.	9	4
		5	22	17	.	.	.	.

NUMBER OF STUDENTS ENROLLED IN SCIENCE COURSES
FOR THE HAMILTON-WENTWORTH RCSSB

			LEV1					
			A		F/B		G	
SCH_NAME	CRSCD3	YEAR	MALE_STDNT	FEM_STDNT	MALE_STDNT	FEM_STDNT	MALE_STDNT	FEM_STDNT
BISHOP RYAN SEPARATE SCHOOL	SBH	3	24	51	.	.	.	.
	SBI	5	12	43	.	.	.	.
	SCH	3	68	48	.	.	.	.
		4	0	2	.	.	.	.
		5	16	36	.	.	.	.
	SEN	2	79	91	10	2	46	46
	SNC	1	74	89	13	7	44	41
	SPH	3	54	35	.	.	20	8
		5	34	20	.	.	.	.
CARDINAL NEWMAN COMPREHENSIVE SCHOOL	SBI	2	0	1	.	.	.	.
		3	9	21	.	.	.	.
		5	28	62	.	.	.	.
	SCA	3	.	.	.	.	8	11
	SCH	3	127	148	.	.	.	.
		5	24	39	.	.	.	.
	SNC	1	113	132	10	4	46	44
		2	108	134	6	9	44	34
	SPA	3	11	5	.	.	4	0
	SPH	5	28	16	.	.	.	.
CATHEDRAL BOYS SEPARATE SCHOOL	SBH	3	15	0	.	.	.	.
	SBI	5	7	0	.	.	.	.
	SCH	3	48	0	.	.	27	0
		5	9	0	.	.	.	.
	SNC	1	52	0	38	0	54	0
		2	55	0	26	0	48	0
	SPH	3	13	0	.	.	16	0
		5	14	0	.	.	.	.
CATHEDRAL GIRLS' SEPARATE SCHOOL	SBH	3	0	60	.	.	.	.
	SBI	5	0	46	.	.	.	.
	SCH	3	0	47	.	.	0	17
		4	0	2	.	.	.	.
		5	0	37	.	.	.	.
	SNC	1	0	83	0	18	0	48
		2	0	88	0	15	0	47
	SPH	3	0	15	.	.	.	.
		5	0	21	.	.	.	.
ST MARY'S SEPARATE SCHOOL	SBI	3	32	66	.	.	5	13
		5	11	25	.	.	.	.
	SCH	3	45	62	.	.	.	.
		4	0	2	.	.	.	.
		5	19	12	.	.	.	.
	SNC	1	78	91	5	3	27	20
		2	81	72	7	1	23	19
	SPH	3	15	10	.	.	3	2
		5	14	7	.	.	.	.
ST THOMAS MORE COMPREHENSIVE SEPARATE SC	SBI	3	27	62	.	.	24	21
		5	24	40	.	.	.	.

APPENDIX B

Science Study Questionnaire

This questionnaire will make up part of a thesis study which examines motivational factors responsible for science course enrolment in high school. Your name is not required and your responses will be held in the strictest confidence. Thank you in advance for your cooperation in completing this questionnaire.

Part A: Demographic Information

Instructions: Please read each question carefully before printing your response. Be as accurate as possible.

1. Name of School (Check one)

   _____Bishop Ryan

   _____Cardinal Newman

   _____Cathedral Boys'

   _____Cathedral Girls'

   _____St. Jean de Brebeuf

   _____St. Mary

   _____St. Thomas More

2. What is your sex? (Check one)

   _____male _____female

3. What is your present age? ____________________

4. What is your religion? ____________________

5. What is your ethnic background (or nationality)?

   ____

6. What is your father's job? ____________________

7. What is your mother's job? ____________________

8. How many children are in your family? ____________________

9. To you, who is the most important member of your family?

   ____

10. At present, what is your grade? (Check one)

______9

______10

______11

______12

______OAC

11. At present, at what level are the majority of the courses you are enrolled in? (Check one)

______Advanced

______General

______Basic

12. Did you ever skip a grade? (Check one)

______Yes

______No

13. What is your favourite subject in high school?

____

14. What subject does your favourite teacher teach?

____

15. Is this teacher ______male or ______female? (Check one)

16. Which science courses are you presently enrolled in?

____

____

____

17. Which of the following areas of science do you prefer to learn about and study?

______Biology

______Chemistry

______Physics

18. How many science courses do you intend to take in high school? (Check one)

_____2

_____3

_____4

_____more than 4

19. Do you have any science or science-related materials at home that might be used to help your science studies? (Check one)

_____Yes

_____No

20. Do your parents help you study science? (Check one)

_____Yes

_____No

21. How far would you like to go in school? (Check one)

_____High school only

_____Community college

_____University

_____Graduate School

_____Professional/Doctorate Studies

22. What kind of job would you like to get when you finish your education? (Check one)

a. homemaker
b. unskilled worker (e.g. factory worker, labourer, truck/bus driver, waiter/waitress)
c. farmer, beekeeper
d. skilled worker (e.g. electrician, plumber, machinist)
e. sales/clerical (e.g. bookkeeper, clerk, secretary, typist, salesperson [real estate, insurance, automobile, furniture])
f. White collar/managerial (e.g. small business owner, manager)
g. Other professional (e.g. executive, doctor, lawyer, architect, engineer, accountant, clergy)
h. Do not know

23. At what age would you like to marry? (Check one)

_____18 - 20

_____21 - 25

_____26 - 30

_____31 - 35

_____over 35

24. How important do you think it is to marry? (Check one)

_____Extremely important

_____Very important

_____Important

_____Not very important

_____Not important at all

25. a) Do you want children? (Check one)

_____Yes

_____No

b) If yes, how many? (Check one)

_____1 _____2 _____3 _____4 or more

Part B: Science and Science-Related Experiences

Instructions: For each statement, choose the letter of the phrase that best describes how you feel about each situation. Circle your response on the scantron sheet and be sure to colour in each circle.

a. Very calm
b. Fairly calm
c. Neutral
d. A little nervous
e. Very nervous

1. Starting science class.

2. Having someone watch you do an experiment.

3. Studying for a test in science.

4. Being asked to explain a topic in science.

5. Using a thermometer to measure temperature of water in an experiment.

6. Taking a science test.

7. Visiting a science museum.

8. Being called on in science class.

9. Showing a classmate the results of your experiment.

10. Asking the teacher a question in science.

11. Taking a quiz in science.

12. Weighing a substance to use in an experiment.

13. Memorizing names of body parts for a science test.

14. Doing a science project.

15. Listening to the teacher in class.

16. Showing your parents your last test.

17. Writing a report for science class.

18. Reading a science magazine and having a friend ask you about it.

19. Writing a report for science class.

a. Very calm
b. Fairly calm
c. Neutral
d. A little nervous
e. Very nervous

20. Following directions to do an experiment.

21. Focusing a microscope.

22. Thinking about a test 1 day before taking it.

23. Reading a chapter in your science book and being asked to explain it.

24. Thinking about a test 1 hour before taking it.

25. Lighting a Bunsen burner.

Part C: Science Ability and Attitudes

Instructions: Use the scales provided to indicate the letter of the phrase that best describes your feelings about each statement. Circle the letter on the scantron sheet and be sure to colour in each circle.

1, Which one of the following best describes your grades so far in high school? (Check one)

a. mostly 90 - 100

b. about half between 90 - 100 and half between 80 - 89

c. mostly 80 - 89

d. about half 80 - 89 and half 70 - 79

e. mostly 70 - 79

f. about half 70 - 79 and half 60 - 69

g. mostly 60 - 69

h. mostly 50 - 59

i. mostly below 50

2. Which one of the following best describes your grades so far in science? (Check one)

a. mostly 90 - 100

b. about half between 90 - 100 and half between 80 - 89

c. mostly 80 - 89

d. about half 80 - 89 and half 70 - 79

e. mostly 70 - 79

f. about half 70 - 79 and half 60 - 69

g. mostly 60 - 69

h. mostly 50 - 59

i. mostly below 50

Use the following scale to indicate the phrase that best describes your feelings about each statement. Choose only one letter, circle it on the scantron sheet. Be sure to colour in your circles.

a. Often
b. Sometimes
c. Seldom
d. Never

How often have you done each of the following activities when <u>not required</u> for science classes? (Check one)

3. Read science articles in magazines.

4. Read science articles in newspapers.

5. Watched science shows on TV.

6. Gone to hear people give science lectures.

7. Read books about science or scientists.

8. Talked about science topics with your friends.

9. Done science projects.

10. Worked with science-related hobbies.

Use the following scale to indicate your feelings about each of the following situations. Choose only one letter, circle it on the scantron sheet. Be sure to colour in your circles.

a. Always
b. Often
c. Sometimes
d. Seldom
e. Never

How often have science classes made you feel:

11. uncomfortable?

12. curious?

13. stupid?

14. confident?

15. successful?

16. unhappy?

Use the following scale to indicate your feelings about each statement. Circle the letter of the best response on the scantron sheet. Be sure to colour in each circle.

a. Strongly agree
b. Agree
c. Undecided
d. Disagree
e. Strongly disagree

17. I usually have been at ease during science tests.

18. I look forward to attending science classes.

19. I feel uneasy about doing science labs.

20. I enjoy science and science projects.

21. I do not enjoy working science problems.

Part D: Women in Science

Instructions: Use the scale indicated to choose the letter that best describes your feelings about each statement. Circle the letter on the scantron sheet and be sure to colour in all the circles.

a. strongly agree
b. agree
c. uncertain
d. disagree
e. strongly disagree

1. Men need to know more about science than women.

2. Girls can do just as well as boys in science.

3. Science is more for males than females.

4. Science careers are just as appropriate for women as for men.

5. Working with advanced technology is more for males than females.

6. Studying about science is just as important for females as for males.

7. More men than women have the logical ability to become scientists.

a. strongly agree
b. agree
c. uncertain
d. disagree
e. strongly disagree

8. Women are as interested in science as are men.

9. Men do not like to work for women supervisors.

10. Women should stick to "women's jobs".

11. Women have as much science ability as men do.

12. Education is wasted on women since they usually get married and raise a family.

13. Women have the ability and endurance to make successful space flights.

14. According to census data, equal job opportunities have now been achieved.

15. I would choose for myself the best qualified dentist regardless of sex.

16. Science classes are useful.

17. The things you learn in science classes have nothing to do with the real world.

18. Science should be required throughout high school.

19. Much of what you learn in science class will be useful.

Use the following scale to choose the letter of the phrase that best describes your feelings about each statement. Circle the letter of the best response and be sure to colour in the circles.

a. always
b. often
c. sometimes
d. seldom
e. never

20. How often are science classes boring?

21. How often are science classes interesting and fun?

22. How often do you like going to science classes.

23. How often are you afraid to ask science questions in class?

24. How often are you reluctant to answer questions in science class?

25. For you, how often are the things you studied in science class too difficult?

How often have science teachers

26. encouraged you to express your opinion?

27. recognized your right to have an opinion of your own?

28. admitted that they did not know the answer to a question?

29. encouraged you to think for yourself?

30. taken a personal interest in your success in science?

Part E: Importance of Science Skills

Instructions: Use the following scale to indicate the importance of the skills described in each statement. Circle the letter of the best response. Be sure to colour in each circle.

a. extremely important
b. very important
c. important
d. somewhat important
e. unimportant

How important do you believe the skill is as something worthwhile for <u>you</u> to learn?

1. To read science textbooks and magazine articles with understanding.

2. To interpret and get meaning from tables, charts, and graphs.

3. To measure, weigh, take readings from instruments accurately.

4. To observe accurately.

5. To use the scientific method of problem-solving.

6. To classify.

7. To evaluate, judge the worth of the facts, the tests, and the conclusions of scientific data.

Part F: Image of Scientists

Complete the following questions with your impressions.

1. If I should ask you to describe a typical scientist, what would this person look like?

2. Would this person be male or female?

3. Would this person be young, middle aged, or old?

The final question is to be answered by <u>female students</u> only

At what period(s) in your life would you like to work on a full time basis? Check applicable times.

______ Before marriage.

______ After marriage but before children.

______ After marriage with preschool children.

______ After marriage but not until children are in elementary school.

______ After marriage but not until children are in high school.

______ After marriage when children have graduated high school.

APPENDIX C

March 12, 1991

Dear Student:

Thank you for helping with my project by taking part in this survey. Before you begin, you should know what the study is all about.

I am interested in finding out if male and female students are studying science throughout high school. I hope to determine who <u>is</u> continuing to enrol in science courses and who <u>is</u> <u>not</u> continuing to enrol in science courses. For those choosing not to enrol in science throughout high school, I want to find out why. That is, I want to try to isolate some reasons or factors for opting out of science. This is where you enter the picture!

You will be anonymously answering some questions in this survey about your family background; your achievement and abilities; your attitudes about science courses, science teachers, and related experiences in classes; your feelings about women in science, your views about the importance of science skills and your image of a scientist. Your responses will be compared by sex, grade levels, and schools to determine if, in fact, differences do exist in these areas, especially between males and females.

The questionnaire will require about 30 - 40 minutes to complete. It is completely anonymous - your name is <u>not</u> required, just your honesty!

Your participation is voluntary. If you would prefer not to complete the survey, please return it to your teacher now, before anything is written on it.

If you choose to complete it, please listen to the instructions given by your teacher and follow them as best you can. Also be sure to read each section and question carefully. If you have any questions at all, please ask your teacher.

Once again, my project hinges on the results of this survey and your assistance and participation is greatly appreciated. I thank you in advance for your help with this project.

Sincerely,

Mrs. Domenica Leone

SCIENCE STUDY QUESTIONNAIRE

This questionnaire will make up part of a thesis study which examines motivational factors responsible for science course enrolment in high school. Your name is not required and your responses will be held in the strictest confidence. Thank you in advance for your cooperation in completing this questionnaire.

Part A: Demographic Information

Instructions: Please read each question carefully before choosing your response. Be as accurate as possible. Colour in the circle that corresponds with your answer on the Scantron sheet.

1. Name of School

   A. Bishop Ryan
   B. Cardinal Newman
   C. Cathedral Boys' or Cathedral Girls'
   D. St. Mary
   E. St. Thomas More

2. What is your sex?

   A. male B. female

3. What is your present age?

   A. 14-15 years B. 15-16 years C. 16-17 years
   D. 17-18 years E. 18-19 years

4. What is your religion?

   A. Roman Catholic B. other

5. How many children are in your family?

   A. one B. two C. three D. four E. five or more

6. To you, who is the most important member of your family?

   A. mother B. father C. sister
   D. brother E. all members are equally important

7. At present, what is your grade? (Choose one only)

   A._9 B. 10 C. 11 D. 12 E. OAC

8. At present, at what level are the <u>majority</u> of the courses you are enrolled in? (Choose one)

   A. Advanced B. General C. Basic

9. Did you ever skip a grade?

   A. Yes B. No

10. Is your favourite teacher

    A. male? B. female?

11. Which of the following areas of science do you prefer to learn about and study?

    A. biology and chemistry
    B. chemistry and physics
    C. physics and biology
    D. all of the sciences

12. How many science courses do you intend to take in high school? (Choose one)

    A. two B. three C. four D. more than four

13. Do you have any science or science-related materials at home that might be used to help your science studies?

    A. Yes B. No

14. Do your parents help you study science?

    A. Yes B. No C. Occasionally

15. How far would you like to go in school? (Choose one)

    A. High school only
    B. Community college
    C. University
    D. Graduate School
    E. Professional/Doctorate Studies

16. What kind of job would you like to get when you finish your education? (Choose one)

    A. unskilled worker (e.g. factory worker, labourer, truck/bus driver, waiter/waitress, homemaker)

    B. skilled worker (e.g. electrician, plumber, machinist, farmer)
    C. sales/clerical (e.g. bookkeeper, clerk, secretary, typist, salesperson [real estate, insurance, automobile, furniture])
    D. White collar/managerial (e.g. small business owner, manager)
    E. Other professional (e.g. executive, doctor, lawyer, architect, engineer, accountant, clergy)

17. At what age would you like to marry? (Choose one)

    A. 18 - 20
    B. 21 - 25
    C. 26 - 30
    D. 31 - 35
    E. over 35

18. How important do you think it is to marry? (Choose one)

    A. Extremely important
    B. Very important
    C. Important
    D. Not very important
    E. Not important at all

19. Do you want children? (Choose one)

    A. Yes
    B. No

20. If yes, how many? (Choose one)

    A. 1 B. 2 C. 3 D. 4 or more

Answer the following questions by writing your responses in the spaces provided on this page.

A. What is your ethnic background (or nationality)?

____

B. What is your father's job (not where he works, what he does)?

____

C. What is your mother's job (not where she works, what she does)?

____

D. What is your favourite subject in high school?

____

E. What subject does your favourite teacher teach?

____

F. Why is this individual your favourite teacher?

____

____

____

G. Which science courses are you <u>presently</u> enrolled in?

____

____

____

Part B: Science and Science-Related Experiences

Instructions: For each statement, choose the letter of the phrase that best describes how you feel about each situation. Circle your response on the scantron sheet and be sure to colour in each circle.

A. Very calm
B. Fairly calm
C. Neutral
D. A little nervous
E. Very nervous

21. Starting science class.
22. Having someone watch you do an experiment.
23. Studying for a test in science.
24. Being asked to explain a topic in science.
25. Using a thermometer to measure temperature of water in an experiment.
26. Taking a science test.
27. Visiting a science museum.
28. Being called on in science class.
29. Showing a classmate the results of your experiment.
30. Asking the teacher a question in science.
31. Taking a quiz in science.
32. Weighing a substance to use in an experiment.
33. Memorizing names of body parts for a science test.
34. Doing a science project.
35. Listening to the teacher in class.
36. Showing your parents your last test.
37. Writing a report for science class.
38. Reading a science magazine and having a friend ask you about it.
39. Writing a report for science class.
40. Following directions to do an experiment.
41. Focusing a microscope.
42. Thinking about a test 1 day before taking it.
43. Reading a chapter in your science book and being asked to explain it.
44. Thinking about a test 1 hour before taking it.
45. Lighting a Bunsen burner.

Part C: Science Ability and Attitudes

Instructions: Use the scales provided to indicate the letter of the phrase that best describes your feelings about each statement. Circle the letter on the scantron sheet and be sure to colour in each circle.

46. Which one of the following best describes your grades so far in high school? (Choose one)

    A. mostly 85 - 100
    B. mostly 70 - 84
    C. mostly 60 - 69
    D. mostly 50 - 59
    E. mostly below 50

47. Which one of the following best describes your grades so far in science? (Choose one)

    A. mostly 85 - 100
    B. mostly 70 - 84
    C. mostly 60 - 69
    D. mostly 50 - 59
    E. mostly below 50

Use the following scale to indicate the phrase that best describes your feelings about each statement. Choose only one letter, circle it on the scantron sheet. Be sure to colour in your circles.

A. Often
B. Sometimes
C. Seldom
D. Never

How often have you done each of the following activities when not required for science classes?

48. Read science articles in magazines.
49. Read science articles in newspapers.
50. Watched science shows on TV.
51. Gone to hear people give science lectures.
52. Read books about science or scientists.
53. Talked about science topics with your friends.
54. Done science projects.
55. Worked with science-related hobbies.

Use the following scale to indicate your feelings about each of the following situations. Choose only one letter, circle it on the scantron sheet. Be sure to colour in your circles.

A. Always
B. Often
C. Sometimes
D. Seldom
E. Never

How often have science classes made you feel:

56. uncomfortable?
57. curious?
58. stupid?
59. confident?
60. successful?
61. unhappy?

Use the following scale to indicate your feelings about each statement. Circle the letter of the best response on the scantron sheet. Be sure to colour in each circle.

A. Strongly agree
B. Agree
C. Undecided
D. Disagree
E. Strongly disagree

62. I usually have been at ease during science tests.
63. I look forward to attending science classes.
64. I feel uneasy about doing science labs.
65. I enjoy science and science projects.
66. I do not enjoy working science problems.

Part D: Women in Science

Instructions: Use the scale indicated to choose the letter that best describes your feelings about each statement. Circle the letter on the scantron sheet and be sure to colour in all the circles.

A. strongly agree
B. agree
C. uncertain
D. disagree
E. strongly disagree

67. Men need to know more about science than women.
68. Girls can do just as well as boys in science.
69. Science is more for males than females.
70. Science careers are just as appropriate for women as for men.
71. Working with advanced technology is more for males than females.
72. Studying about science is just as important for females as for males.
73. More men than women have the logical ability to become scientists.
74. Women are as interested in science as are men.
75. Men do not like to work for women supervisors.
76. Women should stick to "women's jobs".
77. Women have as much science ability as men do.
78. Education is wasted on women since they usually get married and raise a family.
79. Women have the ability and endurance to make successful space flights.
80. According to census data, equal job opportunities have now been achieved.
81. I would choose for myself the best qualified dentist
82. regardless of sex.
83. Science classes are useful.
84. The things you learn in science classes have nothing to do with the real world.
85. Science should be required throughout high school.
86. Much of what you learn in science class will be useful.

Use the following scale to choose the letter of the phrase that best describes your feelings about each statement. Circle the letter of the best response and be sure to colour in the circles.

A. always
B. often
C. sometimes
D. seldom
E. never

87. How often are science classes boring?
88. How often are science classes interesting and fun?
89. How often do you like going to science classes.
90. How often are you afraid to ask science questions in class?
91. How often are you reluctant to answer questions in science class?
92. For you, how often are the things you studied in science class too difficult?

How often have science teachers

93. encouraged you to express your opinion?
94. recognized your right to have an opinion of your own?
95. admitted that they did not know the answer to a question?
96. encouraged you to think for yourself?
97. taken a personal interest in your success in science?

Part E: Importance of Science Skills
Instructions: Use the following scale to indicate the importance of the skills described in each statement. Circle the letter of the best response. Be sure to colour in each circle.

A. extremely important
B. very important
C. important
D. somewhat important
E. unimportant

How important do you believe the skill is as something worthwhile for <u>you</u> to learn?

98. To read science textbooks and magazine articles with understanding.
99. To interpret and get meaning from tables, charts, and graphs.
100. To measure, weigh, take readings from instruments accurately.
101. To observe accurately.
102. To use the scientific method of problem-solving.
103. To classify.
104. To evaluate, judge the worth of the facts, the tests, and the conclusions of scientific data.